AD-762 441

INTERACTIONS AMONG THE VARIOUS PHENOMENA INVOLVED IN THE DESIGN OF DYNAMIC AND ROTARY MACHINERY AND THEIR EFFECTS IN RELIABILITY. VOLUME II: RESEARCH DATA

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Prepared for:

Office of Naval Research

31 August 1972

DISTRIBUTED BY:

NTIS

National Technical Information Service
U. S. DEPARTMENT OF COMMERCE
5285 Port Royal Road, Springfield Va. 22151

AD 762441

FIFTH TECHNICAL REPORT

VOL. II - RESEARCH DATA

INTERACTIONS AMONG THE VARIOUS PHENOMENA INVOLVED IN THE DESIGN OF DYNAMIC AND ROTARY MACHINERY AND THEIR EFFECTS ON RELIABILITY

OFFICE OF NAVAL RESEARCH
CONTRACT NOOO14-67-A-0209-0002

AUGUST 31, 1972

ENGINEERING EXPERIMENT STATION
COLLEGE OF ENGINEERING
THE UNIVERSITY OF ARIZONA
TUCSON, ARIZONA

Fifth Technical Report

1 September 1971 - 31 August 1972

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VOL. II - RESEARCH DATA

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Arlington, Va.

Contract N00014-67-A-0209-0002

31 August 1972

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7.0 APPENDICES

APPENDIX A

PROGRAM WIEDEMANN

(MODIFIED MACHINE)

```
      PROGRAM WIEDEMA (INPUT,OUTPUT,TAPE 5 = INPUT)
C LOADING PROGRAM FOR WIEDEMANN FATIGUE TEST MACHINE
C CALCULATION OF UPPER PAN LOAD SCHEDULE
C INITIALIZE STRESS CONCENTRATION DATA
      I = 1
C DETERMINE TEST SPECIMEN SECTION DIAMETER
      D = .0937
C PRINT TABLE HEADINGS
      3 PRINT 7
      7 FORMAT (1H1.7X,*RAD*.5X,*CKF*,8X,*SN*,8X,*SU*,6X,*WUPA*)
C INITIALIZE UNNOTCHED STRESS TO ZERO
      SU = 00000.
      READ(5,1) RAD,QEST,CKT
    1 FORMAT(3F10.3)
C COMPUTE REQUIRED UPPER PAN ADDED LOAD FOR AN APPLIED STRESS
    4 WUPA = 18.39 - ((SU)*(D**3))/23.73
C CALCULATE EFFECTS OF STRESS CONENCTRATION
C CALCULATE FATIGUE THEORETICAL STRESS COMCENTRATION FACTOR
    2 CKF = (QEST*(CKF-1.0)) + 1.0
C CALCULATE NOTCHED SPECIMEN ENDURANCE STRENGTH ≠ THEORETICAL
      SN = SU*CKF
      PRINT 8, RAD,CKF,SN,SU,WUPA
    8 FORMAT(1X.2F10.0,F10.2)
C INCREMENT STRESS IN STEPS OF 1000 PSI
      SU = SU + 1000.
      IF(SU.LE.60000.)  GO TO 4
      IF(I.GE.5)  GO TO 10
    9 I = I   1
      GO TO 3
   10 STOP
      END
```

RAD	CKF	SN	SU	WUPA
1.870	1.0[illegible]	0	0	18.39
1.870	1.000	1000	1000	18.36
1.870	1.000	2000	2000	18.32
1.870	1.000	3000	3000	18.29
1.870	1.000	4000	4000	18.25
1.870	1.000	5000	5000	18.22
1.870	1.000	6000	6000	18.18
1.870	1.000	7000	7000	18.15
1.870	1.000	8000	8000	18.11
1.870	1.000	9000	9000	18.08
1.870	1.000	10000	10000	18.04
1.870	1.000	11000	11000	18.01
1.870	1.000	12000	12000	17.97
1.870	1.000	13000	13000	17.94
1.870	1.000	14000	14000	17.90
1.870	1.000	15000	15000	17.87
1.870	1.000	16000	16000	17.84
1.870	1.000	17000	17000	17.80
1.870	1.000	18000	18000	17.77
1.870	1.000	19000	19000	17.73
1.870	1.000	20000	20000	17.70
1.870	1.000	21000	21000	17.66
1.870	1.000	22000	22000	17.63
1.870	1.000	23000	23000	17.59
1.870	1.000	24000	24000	17.56
1.870	1.000	25000	25000	17.52
1.870	1.000	26000	26000	17.49
1.870	1.000	27000	27000	17.45
1.870	1.000	28000	28000	17.42
1.870	1.000	29000	29000	17.38
1.870	1.000	30000	30000	17.35
1.870	1.000	31000	31000	17.32
1.870	1.000	32000	32000	17.28
1.870	1.000	33000	33000	17.25
1.870	1.000	34000	34000	17.21
1.870	1.000	35000	35000	17.18
1.870	1.000	36000	36000	17.14
1.870	1.000	37000	37000	17.11
1.870	1.000	38000	38000	17.07
1.870	1.000	39000	39000	17.04
1.870	1.000	40000	40000	17.00
1.870	1.000	41000	41000	16.97
1.870	1.000	42000	42000	16.93
1.870	1.000	43000	43000	16.90
1.870	1.000	44000	44000	16.86
1.870	1.000	45000	45000	16.83
1.870	1.000	46000	46000	16.80
1.870	1.000	47000	47000	16.76
1.870	1.000	48000	48000	16.73

APPENDIX B

PROGRAM WIEDEMANN

(UNMODIFIED MACHINE)

```
      PROGRAM RRMOORE (INPUT,OUTPUT,TAPE 5  = INPUT,TAPE 6  = OUTPUT)
C LOADING PROGRAM FOR RRMOORE FATIGUE TEST MACHINE
C INITIALIZE STRESS CONCENTRATION DATA
      I=1
C DETERMINE TEST SPELCIMEN SECTION DIAMETER
      D = .2700
C PRINT TABLE HEADINGS
    3 WRITE(6,8)
    8 FORMAT  (1H1,6X,*RAD*,6X,*CKF*,8X,*SN*,8X,*SU*,6X,*WPA*/)
C INITIALIZE UNNOTCHED STRESS TO ZERO
      SU = 00000.
      READ(5,1) RAD,CKF
    1 FORMAT (2F10.3)
C COMPUTE REQUIRED ADDED PAN LOAD FOR AN APPLIED STRESS
    4 WPA =( (3.1416 * (D**3.) * SU)/64.) - 9.76
C CALCULATE NOTVEH SPECIMEN ENDURANCE STRENGTH - THEORETICAL
      SN = SU * CKF
      WRITE(6,9) RAD,CKF,SN,SU,WPA
    9 FORMAT (1X,2F9.3,2F10.0,F10.2)
C INCREMENT STRESS IN STEPS OF 1000 PSI
      SU = SU + 1000.
      IF(SU.LE.95000.) GO TO 4
      IF(I.GE.5) GO TO 10
   11 1 = I+1
      GO TO 3
   10 STOP
      END
```

RAD	CKF	SN	SU	WPA
.031	1.510	0	0	-9.76
.031	1.510	1510	1000	-8.79
.031	1.510	3020	2000	-7.83
.031	1.510	4530	3000	-6.86
.031	1.510	6040	4000	-5.90
.031	1.510	7550	5000	-4.93
.031	1.510	9060	6000	-3.96
.031	1.510	10570	7000	-3.00
.031	1.510	12080	8000	-2.03
.031	1.510	13590	9000	-1.06
.031	1.510	15100	10000	-.10
.031	1.510	16610	11000	.87
.031	1.510	18120	12000	1.83
.031	1.510	19630	13000	2.80
.031	1.510	21140	14000	3.77
.031	1.510	22650	15000	4.73
.031	1.510	24160	16000	5.70
.031	1.510	25670	17000	6.67
.031	1.510	27180	18000	7.63
.031	1.510	28690	19000	8.60
.031	1.510	30200	20000	9.56
.031	1.510	31710	21000	10.53
.031	1.510	33220	22000	11.50
.031	1.510	34730	23000	12.46
.031	1.510	36240	24000	13.43
.031	1.510	37750	25000	14.39
.031	1.510	39260	26000	15.36
.031	1.510	40770	27000	16.33
.031	1.510	42280	28000	17.29
.031	1.510	43790	29000	18.26
.031	1.510	45300	30000	19.23
.031	1.510	46810	31000	20.19
.031	1.510	48320	32000	21.16
.031	1.510	49830	33000	22.12
.031	1.510	51340	34000	23.09
.031	1.510	52850	35000	24.06
.031	1.510	54360	36000	25.02
.031	1.510	55870	37000	25.99
.031	1.510	57380	38000	26.96
.031	1.510	58890	39000	27.92
.031	1.510	60400	40000	28.89
.031	1.510	61910	41000	29.85
.031	1.510	63420	42000	30.82
.031	1.510	64930	43000	31.79
.031	1.510	66440	44000	32.75
.031	1.510	67950	45000	33.72
.031	1.510	69460	46000	34.68

APPENDIX C

PROGRAM CYTOFR (Updated)

This program calculates estimates of the mean and standard deviation of the cycles-to-failure data for both the normal and the lognormal distributions, and calculates the moment coefficients of skewness and kurtosis. It also performs the Chi-squared and the Kolmogorov-Smirnov goodness-of-fit tests.

The program has been updated since it was previously reported.

The main program was revised to incorporate a sort routine to preclude the necessity for manually ordering the data inputs. Subroutine CHISQA (Chi-squared test) was modified to provide for automatic combining of cells at the tails of the distribution when the end cells do not contain at least five failure data points. Subroutine GRAPH was added to the program to plot a histogram of the cycles-to-failure data based on the cell widths and number of failure data points per cell computed by the CHISQA subroutine. The theoretical distribution curve represented by the parameters estimated by the main program is sketched and superimposed over the histogram. The plotting of the histogram and of the distribution is done by the Cal-Comp plotter from an output tape generated by the computer.

The data deck for operating program CYTOFR is in three logical sections per problem. The first section consists of two cards. Card one consists of three titles, while card two specifies the parameters necessary for the statistical calculations in CYTOFR.

The second, logical section is a variable number of cards, each specifying up to eight data points for analysis.

Section three provides parameters for plotting the normal and lognormal distributions. The first card is a parameter list for the normal distribution plot, followed by exactly six cards of footnotes. Next is a parameter list card for the lognormal distribution.

Multiple prob.·.ms may be executed by stacking complete data sets behind each other. A list of important variables and symbols in program CYTOFR using Fortran language follows:

List of Definitions for Program to fit Normal and Log-Normal Distributions to Cycles-to-Failure Data (PROGRAM CYTOFR)

Main Program:

NDATA = DATA = number of observations.

STRLV = stress level in psi.

AKURCY = accuracy to which cycles-to-failure data are known.

RATIO = stress ratio

X(I) = cycles-to-failure data

CUMFRQ(I) = cumulative frequency of each X(I); ie, number of X's less than or equal to X(I).

PCAREA(I) = CUMFRQ(I)/NDATA

Subroutine to calculate the mean and standard deviation of the cycles-to-failure data (SUBROUTINE MEAN)

SIGMA = sum of the X(I)'s

XMEAN = average of the X(I)'s

TOP2 = $\sum_{i=i}^{n} (X(I)-XMEAN)^2$

DEV = standard deviation of the X(I)'s

Function subroutine to find the area under the normal curve (FUNCTION PROB(X)).

X = abscissa value for which corresponding area is desired.

PROB = desired area.

Subroutine for Chi-square goodness-of-fit test (SUB-ROUTINE CHISQA).

K = number cells.

XMAX = largest value of cycles-to-failure.

XMIN = smallest value of cycles-to-failure.

CSV = cell starting value.

CEV = cell end value.

CLB = cell lower bound.

CUB = cell upper bound.

FREQ(J) = number of observations in J^{th} cell.

REQAREA(J)= expected value of J^{th} cell.

CHISQR = total Chi-square value.

U(I) = Chi-square value of I^{th} cell.

Subroutine for Kolmogorov-Smirnov test (SUBROUTINE DTEST).

Z(I) = abscissa value on standard normal curve for a given X(I).

ARUNCN = area under standard normal curve from - to Z(I).

DSTAT(I) = absolute difference between the data cumulative frequency and the hypothesized cumulative frequency.

XMEAN = average of the X(I)'s.

DEV = standard deviation of the X(I)'s

PROB(T) = area under the standard normal curve from -T to +T.

Subroutine to calculate the moment coefficients of skewness and kurtosis (SUBROUTINE ALPHA).

ALPHA3 = moment coefficient of skewness.

ALPHA4 = moment coefficient of skewness.

VAR $= \sum_{i=i}^{n} (X(I)-\underline{X})^2$

TOP3 $= \sum_{i=i}^{n} (X(I)-\underline{X})^3$

SKEW = third moment of the data.

STDEV = biased estimator for standard deviation.

TOP4 $= \sum_{i=i}^{n} (X(I)-\underline{X})^4$

TKURT = fourth moment of the data.

DATA DECK STRUCTURE

Card	Columns	Description
1	1-20	Twenty character descriptive title to appear at the top of each printed output page.
	21-40	Twenty character descriptive title of the input data will appear on printed output, as well as the X-axis label for both slots.
	41-50	Unit of data measurement (cycles, inches, etc.).
2	1-10	Number of data points on following card(s). Must have a decimal point.
	11-20	Stress level. Must have a decimal point.
	21-30	Stress ratio. Must have a decimal point.
	31-40	Accuracy. Must have a decimal point.
3 to n**	1-10, 11-20, ..., 71-80	Data points, punched eight per card until all points are exhausted. Must have decimal points.
n + 1	1-10	The letters "NORMAL" followed by four blank spaces.
	11-20	Length of the X-axis in inches. If zero or blank, 6.0 is assumed. Decimal point is necessary.
	21-30	Length of the X-axis in inches. If zero or blank, 5.0 is assumed; if greater than 5.0, 5.0 is assumed. Decimal point is necessary.

**The notation 3rd to n is intended to mean from the third card to the nth card. In the case of 34 data points, the second section of data would stretch from the 3rd to 7th card .

Card	Columns	Description
	31-40	Minimum X-axis value. The plotting program may find it necessary to alter this value slightly. If absent or zero, a resonable maximum will be assumed. The decimal point is necessary.
	41-50	Minimum Y-axis value. This should be blank or 0.
	51-60	Maximum X-axis value. Follow same rules as minimum X-axis value.
	61-70	Maximum Y-axis value. If absent or zero, the plotting program will search for the smallest even number greater than (or equal to) the height of the tallest histogram block, an automatic adjustment will be made. The decimal point is necessary.
	71-80	Height of lettering on graph, if 0 < height < .15. Otherwise this parameter will be set to equal .15.
n + 2 to n + 7	1-50	Footnotes punched as they will appear on the normal graph.
n + 8	1-10	The letters "LOG-NORMAL." Otherwise the same as card n + 1.

The program for CYTOFR listing in Fortran language follows:

```
      PROGRAM CYTOFR (INPUT,OUTPUT,TAPE1=INPUT,TAPE2)
C-----PROGRAM TO FIT NORMAL AND LOG-NORMAL CURVE TO DATA AND CHECK
C-----GOODNESS OF FIT.
      COMMON CUMFRQ(100),NDATA,X(100),DEV,XMEAN,CLB(9),CUB(9),FREQ(9),K,
     1 CHISQR,TITLE(2),SUBTITL(2),CSV(9),CEV(9),PCAREA(100),DSTAT(100),
     2  AREA(9),REQAREA(9),EXFREQ(9),U(9),Z(100),NX(100),DATA,AKURCY,
     3 XMAX,XMIN,PSI,CD,D,RATIO,XLENGTH,YLENGTH,YMAX,YMIN,XMA,XMI,
     4 HLETTEF,COM(3),W,ALPHA3,ALPHA4,FOOT(30),IT,SKS,UNIT
      INTEGER TITLE,SUBTITL,FOOT
      EXTERNAL PROB
C
C     INITIALIZE PLOTTER
C
      CALL INITIAL (0,2,0,3,0)
710   PRINT 1
C-----NDATA=DATA=NUMBER OF OBSERVATIONS
C-----STRLV = STRESS LEVEL IN PSI.
C     X=NUMBER OF CYCLES TO FAILURE
      READ 500,TITLE,SUBTITL,UNIT
  500 FORMAT(8A10)
      IF(EOF(1)) 56,5
    5 READ 501,DATA,STPLEV,RATIO,AKURCY
  501 FORMAT(8F10.0)
      NDATA=DATA
      READ 501,(X(I),I=1,NDATA)
C
C     SORT X(I) TERMS IN ASCENDING ORDER.
C
      K=NDATA-1
      IF(K.LE.0) GO TO 30
      DO 20 I=1,K
      N=NDATA-I
      ISTOP=0
      DO 10 J=1,N
      IF(X(J).LE.X(J+1)) GO TO 10
      SAVE=X(J)
      X(J)=X(J+1)
      X(J+1)=SAVE
      ISTOP=ISTOP+1
   10 CONTINUE
      IF(ISTOP.EQ.0) GO TO 30
   20 CONTINUE
C
C     SET CUMFRQ(I) ARRAY
C
   30 DO 40 I=1,NDATA
   40 CUMFRQ(I)=I
C
C     RESET SOME CUMFRQ(I) ENTRYS IF X(I)=X(I+1) OCCURS
```

```
C
      DO 56 I=2,NDATA
   56 CONTINUE
C-----PCAREA = F(N) OF OBSERVATIONS
      DO 759 I=1, NDATA
759   PCAREA(I) = CUMFRQ(I)/DATA
      PRINT 408,TITLE,SUBTITL
  408 FORMAT(*1*,55X,2A10,/,42X,*NORMAL DISTRIBUTION FITTED TO *,2A10,
     1///)
      IF (RATIO.EQ.0.0) GO TO 414
      PRINT 402, STRLEV, RATIO
  402 FORMAT(29X,*STRESS LEVEL =*,F7.1,* PSI.*,16X
     1,14HSTRESS RATIO =,F6.3//)
      GO TO 415
414   PRINT 416, STRLEV


  416 FORMAT(29X,*STRESS LEVEL =*,F7.1,* PSI.*,16X
     1,23HSTRESS RATIO = INFINITY//)
  415 PRINT 404,SUBTITL
  404 FORMAT(56X,2A10,/)
      PRINT 403, (X(I),I=1,NDATA)
  403 FORMAT(6F21.4)
      PRINT 3
3     FORMAT (1H0)
      CALL MEAN
      CALL CHISQA
      CALL DTEST
      CALL ALPHA
      READ 502,IT,XLENGTH,YLENGTH,XMI,YMIN,XMA,YMAX,HLETTER
  502 FORMAT(A1,9X,7F10.0)
      READ 503,FOOT
  503 FORMAT(5A10)
      IF(IT.NE.1HN) GO TO 57
      CALL GRAPH
   53 AKURCY=.00001
      DO 54 I=1,NDATA
      NX(I) =(ALOG(X(I)/20.)+ALOG(20.))*100000.  + .5
      X(I) = NX(I)
54    X(I) = X(I)/100000.
      PRINT 1, TITLE
    1 FORMAT(*1*,55X,2A10)
      PRINT 401,SUBTITL
  401 FORMAT(38X,*LOG-NORMAL DISTRIBUTION FITTED TO *,2A10,///)
      IF (RATIO.EQ.0.0) GO TO 417
      PRINT 402, STRLEV, RATIO
      GO TO 418
417   PRINT 416, STRLEV
  418 PRINT 2,SUBTITL
    2 FORMAT(49X,*LOGS OF THE *,4A10,/)
      PRINT 413, (X(I),I=1,NDATA)
```

```
 413 FORMAT(6(8X,F12.4))
     PRINT 3
     CALL MEAN
     CALL CHISQA
     CALL DTEST
     CALL ALFHA
     READ 502,IT,XLENGTH,YLENGTH,XMI,YMIN,XMA,YMAX
     IF(IT.NE.1HL) GO TO 57
     CALL GRAPH
     GO TO 710
  56 CALL PLOT (0.,0.,999)
     CALL EXIT
  57 CALL PLOT (0.,0.,999)
     STOP 1111
     END
     SUBROUTINE MEAN
C-----SUBROUTINE TO CALCULATE THE MEAN AND STANDARD DEVIATION OF DATA.
     COMMON CUMFRQ(100),NDATA,X(100),DEV,XMEAN,CLB(9),CUB(9),FREQ(9),K,
    1 CHISQR,TITLE(2),SUBTITL(2),CSV(9),CEV(9),PCAREA(100),DSTAT(100),
    2  AREA(9),REQAREA(9),EXFREQ(9),U(9),Z(100),NX(100),DATA,AKURCY,
    3  XMAX,XMIN,PSI,CD,D,R,XLENGTH,YLENGTH
     SIGMA= 0.0
     DO 8 I=1, NDATA
8    SIGMA=SIGMA+ X(I)
     XMEAN = SIGMA/DATA
     TOP2 = 0.0
     DO 9 I=1,NDATA
9    TOP2 = TOP2 + (X(I) - XMEAN)**2
     DEV =SQRT(TOP2/(DATA - 1.0))
     PRINT 14, XMEAN


     PRINT 15, DEV
  14 FORMAT(10X,*SAMPLE MEAN =*,F14.4)
  15 FORMAT(10X,*STD. DEVIATION=*,F12.4)
     RETURN
     END
     FUNCTION PROB(X)
C-----THIS SUBROUTINE GIVES AREA UNDER NORMAL CURVE FROM -Z TO +Z
C     WITH AN ACCURACY OF 0.00005
C-----Z VALUE GIVEN BY CALLING PROGRAM MUST BE A POSITIVE NUMBER.
     IF (X-1.2) 11,11,12
11   XSQ=X*X
     PROB= 0.79788455*X*(0.9999977+-XSQ*(0.16659433-XSQ*(0.02463831O-XS
    1Q*0.0023974867)))
     RETURN
12   IF(X-2.9) 13,14,14
13   XSQ=X*X
     PROB=1.0
     PTERM=1.0
     FACTOR=1.0
```

```
      ODDINT=3.1
970   PTERM=-PTERM*XSQ/(2.0*FACTOR)
      TERM=PTERM/ODDINT
      PROB=PROB+TERM
      IF( ABS (TERM) - 0.00007 ) 80,90,90
90    FACTOR =FACTOR+1.0
      ODDINT=ODDINT+2.0
      GO TO 970
80    PROB=0.79788455*X*PROB
      RETURN
14    RECXSQ= 1.0 / (X*X)
      PROB= 1.0 - 0.79788453*EXP(-X*X/2.0)/X*(1.0-RECXSQ*(1. -RECXSQ*(3.
     1 - RECXSQ*(15. - RECXSQ*105. ))))
      RETURN
      END
      SUBROUTINE CHISQA
C-----SUBROUTINE TO FIT A HISTOGRAM TO THE DATA AND PERFORM THE CHI-SQUA
C-----TEST FOR THE NORMAL OR LOG-NORMAL DISTRIBUTIONS.
      COMMON CUMFRQ(100),NDATA,X(100),DEV,XMEAN,CLB(9),CUB(9),FREQ(9),K,
     1 CHISQR,TITLE(2),SUBTITL(2),CSV(9),CEV(9),PCAREA(100),DSTAT(100),
     2  AREA(9),REQAREA(9),EXFREQ(9),U(9),Z(100),NX(100),DATA,AKURCY,
     3 XMAX,XMIN,PSI,CD,D,R,XLENGTH,YLENGTH,YMAX,YMIN,XMA,XMI,H,COM(3),W
      DIMENSION XFREQ(9)
      CHISQR= .0
C-----TO DETERMINE THE NUMBER OF CLASS INTERVALS,K
      K= 1    +3.3  *ALOG10(DATA)
      REALK=K
C-----IN ORDER TO DETERMINE THE RANGE,FIND X(MAX) AND X(MIN)
      XMAX=X(1)
      XMIN= X(1)
      DO 17 I=1,NDATA
      IF( X(I).GT.XMAX ) XMAX = X(I)
17    IF(X(I).LT. XMIN) XMIN=X(I)
       RANGE=  XMAX- XMIN
C------TO DETERMINE THE CLASS INTERVAL WIDTH,W
C-----ROUTINE TO ROUND OFF CLASS WIDTH TO SAME NUMBER OF PLACES AS THE A
      DIVIDE = 1.0/AKURCY
   20 KW=(((RANGE+AKURCY)/REALK)+.5*AKURCY)*DIVIDE
      RK1 = KW
      W = RK1/DIVIDE
      DO 22 I=1,K
      A=I
      B = 0.5*AKURCY
      CSV(I)= XMIN+(A-1.0)*W
      CEV(I)= CSV(I)+W-AKURCY
      CLB(I)= CSV(I)-B
22    CUB( I ) = CEV(I)+B
      CEV(K) = XMAX
      CUB(K) = CEV(K) +B
      DO 23 J=1,K
```

```
      XFREQ(J)=0.0
 23   FREQ(J)=0.0
      DO 24 I=1,NDATA
      DO 24 J=1,K
      IF(X(I).GE.CLB(J).AND.X(I).LT.CUB(J)) FREQ(J)=FREQ(J)+1.0
 24   CONTINUE
      DO 25 J=1,K
   25 XFREQ(J)=FREQ(J)
      Y=0.
      PRINT 62,XMAX
      PRINT 63,XMIN
      PRINT 65,W
C-----CHI-SQUARE TEST
   26 PRINT 41
      PRINT 406
      DO 30 I=1,K
      Z(I)=( CUB(I)- XMEAN) / DEV
      T= ABS( Z(I) )
 30   AREA(I)= PROB(T)/2.0
      REQAREA(1) = 0.5 - AREA(1)
       MANU=K-1
      DO 32 I=2,MANU
      M=I-1
      IF(  (Z(I).GE.0.0.AND.Z(M).GE.0.0).OR.( Z(I).LE.0.0.AND.Z(M).LE.0.
     1 )  ) GO TO 31
      REQAREA(I)= AREA(I)+AREA(M)
      GO TO 32
 31   REQAREA(I) = ABS( AREA(I)-AREA(M) )
 32   CONTINUE
      REQAREA(K)= 0.5-AREA(K-1)
      DO 80 M=1,K
   80 EXFREQ(M)=DATA*REQAREA(M)
      I=1
 2420 IF(FREQ(I).GE.5.) GO TO 2430
      EXFREQ(I+1)=EXFREQ(I+1)+EXFREQ(I)
      FREQ(I+1)=FREQ(I+1)+FREQ(I)
      J=I
      DO 2425 L=1,J
      EXFREQ(L)=0.
 2425 FREQ(L)=0.
      I=I+1
      GO TO 2420
 2430 I=K
 2440 IF(FREQ(I).GE.5.) GO TO 2450
      EXFREQ(I-1)=EXFREQ(I-1)+EXFREQ(I)
      FREQ(I-1)=FREQ(I-1)+FREQ(I)
      DO 2445 L=I,K
      EXFREQ(L)=0.
 2445 FREQ(L)=0.
      I=I-1
```

```
      GO TO 2443
 2450 CONTINUE
      DO 85 M=1,K
      U(M)=0.0
      IF(EXFREQ(M).EQ.0.) GO TO 85
      U(M)=((EXFREQ(M)-FREQ(M))**2)/EXFREQ(M)
   85 CONTINUE
      DO 90 M=1,K
   90 CHISQR=CHISQR+U(M)
C-----TO PRINT THE TABLE FOR CHI-SQUARE TEST
      DO 33 I=1,K
33    PRINT 34,I,CLB(I),CUB(I), EXFREQ(I),FREQ(I),U(I)
      PRINT 35, CHISQR
      DO 150 I=1,K
  150 FREQ(I)=XFREQ(I)
   62 FORMAT(10X,*MAXIMUM VALUE=*,F13.4)
   63 FORMAT(10X*MINIMUM VALUE=*,F13.4)
   65 FORMAT(10X,*CLASS WIDTH=*,F15.4)
41    FORMAT(1H0)
406   FORMAT (8X,5H CELL,10X,10HLOWER CELL,11X,10HUPPER CELL,13X,8HEXPEC
     1TED,13X,8HOBSERVED,13X,11HCHI-SQUARED/8X,6HNUMBER,13X,8HBOUNDARY,
     213X, 8HBOUNDARY,13X,9HFREQUENCY,12X,9HFREQUENCY,12X,13HVALUE OF CE
     3LL/)
   34 FORMAT(10X,I2,F20.4,4F21.4)
   35 FORMAT(*0*,77X,*TOTAL CHI-SQUARED VALUE =*,F13.4)
      RETURN
      END
      SUBROUTINE DTEST
C-----SUBROUTINE TO CALCULATE THE KOLMOGOROV-SMIRNOV D-VALUES.
      COMMON CUMFRQ(100),NDATA,X(100),DEV,XMEAN,CLB(9),CUB(9),FREQ(9),K,
     1 CHISQR,TITLE(2),SUBTITL(2),CSV(9),CEV(9),PCAREA(100),DSTAT(100),
     2  AREA(9),REQAREA(9),EXFREQ(9),U(9),Z(100),NX(100),DATA,AKURCY,
     3 XMAX,XMIN,PSI,CD,D,R,XLENGTH,YLENGTH,YMAX,YMIN,XMA,XMI,
     4 H,COM(3),W,ALPHA3,ALPHA4,FOOT(30),IT,SKS
      INTEGER TITLE,SUBTITL
      DO 706 I=1, NDATA
      Z(I) = (X(I) - XMEAN)/DEV
      IF (Z(I)) 703, 704, 705
703   T =ABS(Z(I))
C-----ARUNCN=AREA UNDER THE NORMAL CURVE TO LEFT OF Z FOR NEGATIVE Z.
      ARUNCN = (1.0-PROB(T))/2.0
      DSTAT(I) = ARUNCN - PCAREA(I)
      GO TO 706
704   DSTAT(I) = .5 - PCAREA(I)
      GO TO 706
705   T = Z(I)
C-----ARUNCP=AREA UNDER THE NORMAL CURVE TO LEFT OF Z FOR POSITIVE Z.
      ARUNCP = PROB(T)/2.0 +  .500
      DSTAT(I) =     (ARUNCP - PCAREA(I))
706   CONTINUE
```

```
      DO 90 I=1,NDATA
   90 DSTAT(I)=ABS(DSTAT(I))
      SKS=DSTAT(1)
      DO 100 I=2,NDATA
      IF(DSTAT(I).GT.SKS) SKS=DSTAT(I)
  100 CONTINUE
      PRINT 708,SUBTITL
      PRINT 707, (DSTAT(I),I=1,NDATA)
  707 FORMAT(FF20.5)
708   FORMAT (//40X,53H D VALUES FOR KOLMOGOROV-SMIRNOV GOODNESS OF FIT
     1TEST,/,44X,*LISTED IN THE SAME ORDER AS *,2A10,/)
      RETURN
      END
      SUBROUTINE ALPHA
      COMMON CUMFRQ(100),NDATA,X(100),DEV,XMEAN,CLB(9),CUB(9),FREQ(9),K,
     1 CHISQR,TITLE(2),SUBTITL(2),CSV(9),CEV(9),PCAREA(100),DSTAT(100),
     2  AREA(9),REQAREA(9),EXFREQ(9),U(9),Z(100),NX(100),DATA,AKURCY,
     3  XMAX,XMIN,PSI,CD,D,RATIO,XLENGTH,YLENGTH,YMAX,YMIN,XMA,XMI,
     + H,COM(3),W,ALPHA3,ALPHA4,FOOT(30),IT,SKS
C-----SUBROUTINE TO CALCULATE THE COEFFICIENTS OF SKEWNESS AND KURTOSIS
C-----CALCULATE THE THIRD MOMENT OF THE DATA (SKEWNESS)
      TOP3 = 0.0
      VAR = 0.0
      DO 710 I =1, NDATA
      VAR = VAR + (X(I) - XMEAN)**2
710   TOP3 = TOP3 +(X(I) - XMEAN)**3
      SKEW = TOP3 / DATA
      STDEV = SQRT(VAR/DATA)
C-----ALPHA3 = MOMENT COEFFICIENT OF SKEWNESS.
      ALPHA3 = SKEW/(STDEV**3)
C-----CALCULATE THE FOURTH MOMENT OF THE DATA (KURTOSIS).
      TOP4 = 0.0
      DO 711 I = 1, NDATA
711   TOP4 = TOP4 + (X(I) - XMEAN)**4
      TKURT = TOP4 / DATA
C-----ALPHA4 = MOMENT COEFFICIENT OF KURTOSIS.
      ALPHA4 = TKURT/(STDEV**4)
      PRINT 712
      PRINT 713
      PRINT 714, ALPHA3, ALPHA4
712   FORMAT (///19X,39HMOMENT COEFFICIENT OF SKEWNESS (ALPHA3),18X,39HM
     1OMENT COEFFICIENT OF KURTOSIS (ALPHA4)/)
  713 FORMAT(21X,*FOR NORMAL DISTRIBUTION ALPHA3 = 0.0*,21X,*FOR NORMAL
     1DISTRIBUTION ALPHA4 = 3.0*,/)
714   FORMAT (28X,25HFOR ABOVE DATA---ALPHA3 =F6.3,26X,25HFOR ABOVE DATA
     1---ALPHA4 =,F6.3)
      RETURN
      END
      SUBROUTINE GRAPH
      COMMON CUMFRQ(100),NDATA,X(100),DEV,XMEAN,CLB(9),CUB(9),FREQ(9),K,
```

```
     1 CHISQR,TITLE(2),SUBTITL(2),CSV(9),CEV(9),PCAREA(100),DSTAT(100),
     2 AREA(9),REQAREA(9),EXFREQ(9),U(9),Z(100),NX(100),DATA,AKURCY,
     3  XMAX,XMIN,PSI,CD,D,R,XLENGTH,YLENGTH,YMAX,YMIN,XMA,XMI,
     4 H,COM(3),W,ALPHA3,ALPHA4,FOOT(30),IT,SKS,UNIT
C      DETERMINE DEFAULTS OR SPECIFIED PARAMETERS
C
       IF(XLENGTH.EQ.0.) XLENGTH=6.
       IF(YLENGTH.EQ.0.) YLENGTH=5.
       IF(YLENGTH.GT.5.) YLENGTH=5.
       DO 1 I=1,K
       IF(YMAX.LT.FREQ(I)) YMAX=FREQ(I)
     1 CONTINUE
       I=YMAX
       IF((I/2*2).NE.I) YMAX=YMAX+1.
     6 XMIN = XMIN - 0.10 * (XMAX - XMIN)
     8 IF(XMIN .LT. 0.0) XMIN = 0.0
       XDIF=XMAX-XMIN
       H = 0.15
C
C      DETERMINE SCALING FACTORS
C
       XSCALE = (XMAX - XMIN) / XLENGTH
       YSCALE = YMAX / YLENGTH
       E = IFIX(ALOG10(XMAX - XMIN))
       STP = 10.0 ** E
C
C      LOCATE PLOTTER PEN
C
       CALL PLOT(XLENGTH+2.,0.,-3)
       CALL PLOT(0.,-11.,-3)
       CALL PLOT (0.,5.,-3)
C
C      CONSTRUCT Y-AXIS
C
       CALL PLOT (0.,YLENGTH,2)
       DIV=1./YSCALE
    21 IF(DIV.GE.(2.*H)) GO TO 22
       DIV=2.*DIV
       GO TO 21
    22 STEP=DIV
       YY=0.
    23 CALL PLOT (.05,YY,3)
       CALL PLOT (-.05,YY,2)
       YN=YY*YSCALE
       CALL NUMBER (-.3,YY,H,YN,0.,-1)
       YY=YY+STEP
       IF(YY.LE.(YLENGTH+.01)) GO TO 23
       YY=(YLENGTH-3.75)/2.
       IF (YY.LT.0.) YY=0.
       CALL SYMBOL (-.4,YY,H,30HFREQUENCY/CLASS INTERVAL WIDTH,90.,30)
```

```
C
C     CONSTRUCT, DRAW, AND LABEL X-AXIS
C
      CALL PLOT (0.,0.,3)
      IF(IT.EQ.1HL) GO TO 25
      XMIN=IFIX(XMIN/STP)
      XMAX=IFIX(XMAX/STP+1.0)
      XSCALE  =  ( XMAX - XMIN ) / XLENGTH * STP
   25 XDIF=XMAX-XMIN
      DIV=10.*XDIF/XLENGTH
      IF(XMIN.EQ.0.) GO TC 26
      CALL PLOT (.3,0.,2)
      CALL PLCT (.35,0.,3)
      CALL PLCT (XLENGTH,0.,2)
      CALL PLOT (.35,.05,3)
      CALL PLOT (.25,-.05,2)
      CALL PLOT (.3,-.05,3)
      CALL PLOT (.4,.05,2)
      GO TO 28
   26 CALL PLOT (XLENGTH,0.,2)
   28 IF(DIV.LT.12.7) GO TO 30
      DIV=DIV/10.
      GO TO 28
   30 DIV=DIV/10.
      IF(DIV.LT.0.2) DIV=DIV*10.
   32 CALL NUMBER (0.,-.2,H,0.,0.,0)
      XX=0.
      DO 35 I=1,25
      XX=XX+1./DIV
      IF(XX.GT.XLENGTH) 40,33
   33 CALL PLOT (XX,.05,3)
      CALL PLOT (XX,-.05,2)
      XN=XMIN+I*XDIF/(DIV*XLENGTH)
      IF(IT.EQ.1HL) GO TO 37
      CALL NUMBER (XX-.1,-.2,H,XN,0.,0)
   35 CONTINUE
   40 DO 41 I=1,2
      IF(SUBTITL(I).EQ.1H ) GO TO 42
   41 CONTINUE
      I=2
      GO TO 43
   37 CALL NUMBER (XX-.2,-.2,H,XN,0.,2)
      GO TO 35
   42 I=I-1
   43 XX=(XLENGTH-I)/2.
      I=I*10
      CALL SYMBOL (XX,-.5,.15,SUBTITL(1),0.,I)
      IF(IT.EQ.1HL) GO TO 46
      IF(STP.LT.1.01) GO TO 48 .
      CALL WHERE (XX,YY)
      CALL SYMBOL (XX,-.5,H,5H X 10,0.,5)
```

```
      CALL WHERE (XX,YY)
      CALL NUMBER (XX+H,YY+.5*H,.5*H,E,0.,-1)
C
C     CONSTRUCT AND DRAW HISTOGRAM
C
      GO TO 48
   46 DO 47 I=1,K
      CLB(I)=(CLB(I)-XMIN)/XSCALE
   47 CUB(I)=(CUB(I)-XMIN)/XSCALE
      GO TO 52
   48 DO 50 I=1,K
      CLB(I)=((CLB(I)/STP)-XMIN)/(XSCALE/STP)
   50 CUB(I)=((CUB(I)/STP)-XMIN)/(XSCALE/STP)
   52 CALL PLOT (CLB(1),0.,3)
      DO 55 I=1,K
      Y=FREQ(I)/YSCALE
      CALL PLOT (CLB(I),Y,2)
      CALL PLOT (CUB(I),Y,2)
   54 CALL PLOT (CUB(I),0.,2)
   55 CONTINUE
C
C     COMPUTE AND DRAW NORMAL CURVE ONE POINT AT A TIME
C
   60 STEP=XDIF*STP/100.
      IF(IT.EQ.1HL) STEP=STEP/STP
      C=1./(DEV*2.50665)
      XX=XMIN
      IF(IT.EQ.1HN) XX=XMIN*STP
      CALL PLOT(0.,0.,3)
      DO 100 I=1,100
      Y=C*EXP(-.5*(XX-XMEAN)**2/DEV**2)/YSCALE*NDATA*W
      XU=(XX-XMIN*STP)/XSCALE
      IF(IT.EQ.1HL) XU=(XX-XMIN)/XSCALE
      IF(XU.GT.20.) GO TO 100
      IF(XMIN.EQ.0.) 80,70
   70 IF(XU.GE.0.4) 80,90
   80 CALL PLOT (XU,Y,2)
      GO TO 100
   90 CALL PLOT (XU,Y,3)
  100 XX=XX+STEP
C
C     OTHER ALPHA-NUMERIC COMMENTARY
C
  130 CALL PLOT(0.,-1.,-3)
      CALL SYMBOL (0.,0.,H,11HMEAN VALUE:,0.,11)
      CALL SYMBOL(0.,-2.*H,H,19HSTANDARD DEVIATION:,0.,19)
      CALL SYMBOL (0.,-4.*H,H,24HKOLMOGOROV-SMIRNOV TEST:,0.,24)
      CALL WHERE(XX,YY)
      XX=XX+H
      CALL SYMBOL (0.,-6.*H,H,17HCHI-SQUARED TEST:,0.,17)
      CALL SYMBOL (0.,-8.*H,H,9HSKEWNESS:,0.,9)
```

```
      CALL SYMBOL(0.,-10.*H,H,9HKURTOSIS:,0.,9)
      IF(IT.EQ.1HN) CALL NUMBER (XX,0.,H,XMEAN,0.,1)
      IF(IT.EQ.1HL) CALL NUMBER(XX,0.,H,XMEAN,0.,3)
      CALL WHERE(XIN,YY)
      XIN=XIN+2.*H
      IF(IT.EQ.1HN) CALL NUMBER(XX,-2.*H,H,DEV,0.,1)
      IF(IT.EQ.1HL) CALL NUMBER(XX,-2.*H,H,DEV,0.,3)
      CALL NUMBER(XX,-4.*H,H,SKS,0.,3)
      CALL NUMBER(XX,-6.*H,H,CHISQR,0.,3)
      CALL NUMBER(XX,-8.*H,H,ALPHA3,0.,3)
      CALL NUMBER(XX,-10.*H,H,ALPHA4,0.,3)
      CALL SYMBOL (XIN,0.,H,UNIT,0.,10)
      CALL SYMBOL (XIN,-2.*H,H,UNIT,0.,10)
      CALL SYMBOL(0.,-14.*H,H,FOOT(1),0.,50)
      CALL SYMBOL(0.,-16.*H,H,FOOT(6),0.,50)
      CALL SYMBOL(0.,-18.*H,H,FOOT(11),0.,50)
      CALL SYMBOL(0.,-20.*H,H,FOOT(16),0.,50)
      CALL SYMBOL(0.,-22.*H,H,FOOT(21),0.,50)
      CALL SYMBOL(0.,-24.*H,H,FOOT(26),0.,50)
      CALL PLOT(XLENGTH+2.,0.,3)
      IF(IT.EQ.1HL) GO TO 150
      XX=(XLENGTH-3.75)/2.
      IF(XX.LT.0.) XX=0.
      CALL SYMBOL (XX,6.25,H,30HNORMAL DISTRIBUTION PARAMETERS,0.,30)
      RETURN
  150 XX=(XLENGTH-4.25)/2.
      IF(XX.LT.0.) XX=0.
      CALL SYMBOL (XX,6.25,H,34HLOG NORMAL DISTRIBUTION PARAMETERS,0.,
     1 34)
      RETURN
      END
```

APPENDIX D

PROGRAM WEIBULL

This program calculates the three Weibull distribution parameters (β, η, and γ) from cycles-to-failure data. It uses those parameters to calculate cycle life for 99% and 90% reliability with a 90% confidence interval. It also performs the Chi-squared and Kolmogorov-Smirnov goodness-of-fit tests.

The program input consists of:

1. A header card - to identify the data block.
2. A set of data cards (in increasing order of cycles-to-failure)
3. Trailer card - to separate data blocks.

The input format for the header card is:

a.	Columns	2-7	date code in alphameric format
b.		8-9	blank
c.		10-40	run identification in alphameric format
d.		41-46	number of data (sample size) in fixed point format
e.		48-52	minimum life increment in fixed point format
f.		53-80	not used

Example:

Dec 71 WEIBULL SL = 100,000 SR = Infinity 35 100

The input format for the data cards is:

a.	Columns	2-7	cycles to failure in fixed point format
b.		9-15	component life in fixed point format (same as for individual fatigue life tests).

c. 20-23 date code (prints out only) in alphameric format

d. 25-27 number of suspensions in fixed point format (either failures just removed from test, or remaining good items when testing by groups).

e. 28-31 blank.

32-35 test code in alphameric format (Note: 28-42 simply prints as punched and can all be left blank or used as comments space).

36-39 lot code in alphameric format.

40-43 blank.

44-80 not used.

The input format for the trailer card is:

a. Columns 1-8 not used.

9-12 punched: - 1.0 in floating point format.

13-80 not used.

By use of the trailer card, the program is written to process as many sets of data as desired. An end of file card is used to signal the end of the last data deck.

Following is a list of important variables and symbols used in program WEIBULL:

List of Definitions for Program WEIBULL

Main Program:

NDAT	=	number of data points
W	=	NDATA + NODATA = DATA = W = V = J = K = FNZ = NODAT
IACTL	=	cycles of test at which a failure occurs
IX=Z	=	cycles of life of specimen at failure
MINL	=	IACTL
INCR	=	minimum life increment
C	=	cumulative life increment
R	=	median rank
R_1	=	log(log) median rank
Q_1	=	log (X - G)
B_1	=	B = weibull slope, β
BETA	=	inverse of slope
E_1	=	E = goodness of fit of regression line
G_1	=	minimum life parameter, γ
U	=	median life
ETA	=	scale parameter = η
CG	=	plus confidence interval
ONE	=	1% life = 99% reliability
CONE	=	upper confidence limit on 1% life
CONM	=	lower confidence limit on 1% life
TEN	=	10% life = 90% reliability
CTEN	=	upper confidence limit on 10% life
CTENM	=	lower confidence limit on 10% life
CU	=	upper confidence limit on median life (U)
CUM	=	lower confidence limit on median life

Subroutine for Kolmogorov-Smirnov Test

(Subroutine DTEST)

Z(I)	=	Weibull cumulative frequency distribution
CUMFREQ(I)	=	cumulative observations (number of failures)
PERCF(I)	=	data cumulative frequency as percentage of failures
DSTAT(I)	=	absolute difference between the data cumulative frequency and the hypothesized cumulative frequency

Subroutine for Chi-squared test (Subroutines CHISQA and CHISQB)

K	=	number of cells
XMAX	=	largest value of cycles to failure
XMIN	=	smallest value of cycles to failure
CSV	=	cell starting value
CEV	=	cell end value
CLB	=	cell lower bound
CUB	=	cell upper bound
FREQ(J)	=	number of observations in J^{th} cell
REQAREA(J)	=	expected value of J^{th} cell (percentage)
EXFREQ(J)	=	expected number of observations

The program WEIBULL listing in Fortran language follows:

```
C-----WEIBULL
C-----WEIBULL
C-----WEIBULL
      PROGRAM WEIBULL (INPUT,OUTPUT,TAPE2=INPUT,TAPE3=OUTPUT,
     1 TAPE1,TAPE4,TAPE5,PLOT=TAPE1)
      DIMENSION Y(100),FREQ(9),CLB(9),CUB(9),DSTAT(100),CUMFRQ(100),
     1 PERCF(100)
      COMMON/N4/ X, R
      COMMON /N5/ IACTL, IX, A1, A2, NOR, A3, A4, A5, A6
    1 J = 0
      K = 0
      I = 0
      ICOUN = 0
      NOD = 0
      XPREV = 0.0
      RPREV = 0.0
      REWIND 4
      REWIND 5
      READ (2,10) NODAT, INCR,M
      IF(EOF(2)) 83,80
   10 FORMAT (40H                                        ,2I6,I8)
   80 IF (NODAT-50) 82,83,83
   82 WRITE (3,40)
   40 FORMAT (5H1DATE,15X,9HRUN IDENT  )
      WRITE (3,10)
    7 READ(2,20) IACTL, IX, A1, A2, NOR, A3, A4, A5, A6
   20 FORMAT (I7, 1X, I7, 1X, 2A4, I3, 4A4, F16.6)
      IF (IX) 4, 3, 2
    2 J = J + 1
    3 K = K + 1
      I = I + 1
      Y(I) = IACTL
      IF (NOR) 6, 6, 5
    6 NOR = 1
    5 NOD = NOD + NOR
      WRITE (4)   IACTL, IX, A1, A2, NOR, A3, A4, A5, A6
      GO TO 7
    4 IF (NODAT - NOD) 8, 9, 8
C-----
C-----   ERROR STOP - NO. OF DATA NOT CORRECT
C-----
    8 WRITE (3,30) NODAT, NOD
   30 FORMAT (22H1NO. OF DATA INCORRECT   /1H0, I6, 5X, I6 / 1H1)
      REWIND 4
      GO TO 83
    9 REWIND 4
      WRITE (3,220) NODAT, J, INCR,M
  220 FORMAT (1H0,4X,11HNO. OF DATA   I6,10X,13H  NO. OF FAIL  I6,10X,
     115H  MIN LIFE INCR  I6,5X,5H  M =  ,I6//)
      WRITE (3,230)
```

```
230  FORMAT (2X,6HACTUAL,3X,4HCOMP,56X,4HCOMP/
    13X,4HLIFE ,4X,4HLIFE ,9H P  DATE  ,4H NOR,6X,10HTEST  LOT
    211X,11HMEDIAN RANK,8X,4HLIFE //)
     Z = 0.0
     W = NODAT
     NDATA = NODAT
     NODATA = NODAT
     DATA = NODAT
     AKURCY = 1.
     V = W
     READ (4)     IACTL, IX, A1, A2, NOR, A3, A4, A5, A6
     REWIND 4
     MINL = IACTL
     FNZ = J
     IF (MINL - 1) 11, 11, 12
 11  MINL = 1
     INCR = 1
     GO TO 13
 12  MINL = MINL - 1
 13  R1 = 1.0 - 2.**(-1.0/W) + (1.0 - 2.**(1.0 - 1.0/W))/(W - 1.0)
     REWIND 4
     DO 14 I = 1, K
     READ (4)     IACTL, IX, A1, A2, NOR, A3, A4, A5, A6
     X = IX
     IF(X) 16, 16, 17
 16  IF(I - 1) 18, 18, 19
 19  IF(XPREV) 18, 18, 21
 21  R1 = RPREV
 18  K1 = NOR
     DO 22 K2= 1, K1
     V = V - 1.0
     RINV=1.0+(W-1.0)*(R1-1.0+2.0**(-1.0/W))/(2.0**(1.0-1.0/W)-1.0)
 22  Z = RINV + (W + 1.0 - RINV)/(1.0 + V)
     R = 0.
     GO TO 15
 17  IF(I - 1) 24, 24, 23
 23  IF(XPREV) 26, 26, 24
 24  Z = Z + (W + 1.0 - Z)/(1.0 + V)
 26  R=1.0-2.0**(-1.0/W)+((Z-1.0)/ (W-1.0))*(2.0**(1.0-1.0/W)-1.0)
     V = V - 1.0
 15  XPREV = X
     RPREV = R
     WRITE(3,241) IACTL, IX, A1, A2, NOR, A3, A4, A5, A6,R,X
241  FORMAT(1X,I7,1X,I7,1X,2A4,1X,I3,3X,4A4,F16.6,F12.0)
     ICOUN = ICOUN + 1
     IF (ICOUN  - 68) 14, 41, 41
 41  ICOUN = 0
     WRITE(3,400)
400  FORMAT (1H1)
 14  WRITE (5) X, R
     REWIND 4
```

```
      REWIND 5
      E1 = 0.0
      IF(Y(1) .LE. 1000) GO TO 117
      IF(Y(1) .GT. 1000 .AND. Y(1) .LE. 10000) GO TO 116
      IF(Y(1) .GT. 10000) INCR = 10000
      GO TO 127
  116 INCR = 1000
      GO TO 127
  117 INCR = 100
      IF(M .GT. 1000) M = M - 1000
  127 E1 = 0.0
      DO 27 KN=M,MINL,INCR
      QSUM = 0.0
      RSUM = 0.0
      QSOS = 0.0
      RSOS = 0.0
      PROD = 0.0
      G = KN - 1
      DO 28 I = 1, K
      READ (5) X,R
      IF(X) 28, 28, 29
   29 IF(X - G) 31, 31, 32
C-----
C-----   NEGATIVE ARGUMENT IN LOG. FUNCTION
C-----
   31 WRITE (3,100)
  100 FORMAT(1H1,26HNEG. ARG. IN LOG. FUNCTION /,1H1)
      GO TO 83
   32 Q1 = ALOG(X - G)
      IF(R) 31, 31, 34
C-----
C-----   NEGATIVE ARGUMENT IN LOG FUNCTION
C-----
   34 R1= ALOG(ALOG(1.0/(1.0 - R)))
      QSUM = QSUM + Q1
      RSUM = RSUM + R1
      QSOS = QSOS + Q1 * Q1
      RSOS = RSOS + R1 * R1
      PROD = PROD + Q1 * R1
   28 CONTINUE
      REWIND 5
      B = (FNZ * PROD - QSUM * RSUM)/(FNZ * QSOS - QSUM * QSUM)
      A = (RSUM - B * QSUM) / FNZ
      C = SQRT((FNZ * QSOS - QSUM * QSUM) * (FNZ * RSOS - RSUM * RSUM))
      E = (FNZ*PROD - QSUM * RSUM)/C
      IF(E - E1) 37, 36, 36
   36 E1 = E
      G1 = G
      B1 = B
      A1 = A
```

```
 27  CONTINUE
  37 M = G + 1 - INCR
  39 IF(INCR - 1000) 38,117,116
  38 ARG = EXP ( -A1)
     BETA = 1.0/B1
     ETA = (0.99967*ARG)**BETA
     U = G1 + (0.69315*ARG)**BETA
     ONE = G1 + (0.01005*ARG)**BETA
     TEN = G1 + (0.105*ARG)**BETA
     B = B1 * (1.0 + 1.163 / SQRT(W))
     CG=G1+.5*(U-G1)*(4.32159**(1.0/B)-0.074**(1.0/B))/(W**(1.0/B))
     CONST = (1.645 * U) / (SQRT(W) * 0.69315 ** BETA)
     FACT = CONST * 10.010038 * (0.995E-02**BETA/B1)
     CONE = ONE + FACT
     CONM = ONE - FACT
     FACT = CONST * 3.1924748 * (0.104360**BETA/B1)
     CTEN = TEN + FACT
     CTENM = TEN - FACT
     FACT = CONST * 0.69315**BETA/(B1 * 0.69315)
     CU = U + FACT
     CUM = U - FACT
     WRITE (3,450) B1, E1, ETA, G1,CG, ONE, CONE, CONM
     WRITE (3,451) TEN, CTEN, CTENM, U, CU, CUM
450  FORMAT (// 12X,13HWEIBULL SLOPE,5X,15HGOODNESS OF FIT ,5X,
    115HSCALE PARAMETER,/5X,3F20.5,//
    213X,12HMINIMUM LIFE ,11X,9HPLUS CONF,/
    35X,2F20.5,//
    49X,16HONE PERCENT LIFE ,11X,9HPLUS CONF ,10X,10HMINUS CONF ,/
    55X,3F20.5 //)
451  FORMAT (1H+,9X,16HTEN PERCENT LIFE,11X,9HPLUS CONF,10X,
    111H MINUS CONF ,/5X,3F20.5,//
    214X,11HMEDIAN LIFE ,11X,9HPLUS CONF ,10X, 10HMINUS CONF ,/
    35X,3F20.5 //)
     CALL DTEST (Y,B1,G1,U,NODATA,DSTAT,PERCF,CUMFRQ,ETA,SKSTAT)
     CALL CHISQA (Y,DATA,NDATA,PROB,AKURCY,XMEAN,DEV,Z,G1,B1,ETA,FREQ,
    1 XMAX,XMIN,CLB,CUB,NUMINTS,CELLWD)
     CALL CHISQB (Y,NDATA,G1,B1,ETA,CHISQR)
     CALL GRAPH (FREQ,XMAX,XMIN,CLB,CUB,SKSTAT,CHISQR,B1,ETA,G1,NDATA,
    1 NUMINTS,CELLWD)
     GO TO 1
  83 CALL PLOT (0.0, 0.0, 999)
     CALL EXIT
     END
```

```
      SUBROUTINE DTEST (Y,B1,G1,U,NODATA,DSTAT,PERCF,CUMFRQ,ETA,SKSTAT)
      DIMENSION Z(100),Y(100),DSTAT(100),PERCF(100),CUMFRQ(100)
C
C     SUBROUTINE TO CALCULATE THE KOLMOGOROV-SMIRNOW D-VALUES
C
      DO 500 I=1,NODATA
      Z(I) = 1.0 - EXP (-(((Y(I)-G1)/ETA)**B1))
  500 CONTINUE
C
C     SET CUMFRQ(2) ARRAY
C
      DO 501 I=1,NODATA
  501 CUMFRQ(I) = I
C
C     PERCF = F(N) OF THE NUMBER OF DATA
C
      DO 502 I=1,NODATA
  502 PERCF(I) = CUMFRQ(I)/NODATA
      DO 503 I=1,NODATA
  503 DSTAT(I) = Z(I) - PERCF(I)
      PRINT 520
      PRINT 521, (DSTAT(I),I=1,NODATA)
  521 FORMAT (6(10X,F10.5))
  520 FORMAT (//40X,53H D VALUES FOR KOLMOGOROV-SMIRNOV GOODNESS OF FIT
     1TEST/41X,52H(LISTED IN THE SAME ORDER AS CYCLES-TO-FAILURE DATA)/)
      SKSTAT = 0.0
      DO 10 I=1,NODATA
      IF(ABS(DSTAT(I)).GT.SKSTAT) SKSTAT = ABS(DSTAT(I))
   10 CONTINUE
      PRINT 400, SKSTAT
  400 FORMAT(//,10X,*KOLMOGOROV-SMIRNOV TEST RESULT = *,F8.5,/)
      RETURN
      END
```

```
      SUBROUTINE CHISQA(X,DATA,NDATA,PROB,AKURCY,XMEAN,DEV,Z
     1,G1,B1,ETA,FREQ,XMAX,XMIN,CLB,CUB,K,W)
C-----SUBROUTINE TO FIT A HISTOGRAM TO THE DATA AND PERFORM THE CHI-SQUA
C-----TEST FOR THE WEIBULL DISTRIBUTION
      DIMENSION X(50), CSV(9), CEV(9), CLB(9), CUB(9),
     1REQAREA(9),AREA(9),EXFREQ(9),    FREQ(9),    U(9)
      CHISQR= .0
C-----TO DETERMINE THE NUMBER OF CLASS INTERVALS,K
      K = 1.0 + 3.3*ALOG10(DATA)
      REALK=K
C-----IN ORDER TO DETERMINE THE RANGE,FIND X(MAX) AND X(MIN)
      XMAX=X(1)
      XMIN= X(1)
      DO 17 I=1,NDATA
      IF( X(I).GT.XMAX ) XMAX = X(I)
17    IF(X(I).LT. XMIN) XMIN=X(I)
      RANGE=  XMAX- XMIN
C------TO DETERMINE THE CLASS INTERVAL WIDTH,W
C-----ROUTINE TO ROUND OFF CLASS WIDTH TO SAME NUMBER OF PLACES AS THE A
      DIVIDE = 1.0/AKURCY
      KW =(((RANGE+AKURCY)/REALK)+.5*AKURCY)*DIVIDE
      RK1 = KW
      W = RK1/DIVIDE
      PRINT 141
      PRINT 241
      PRINT 177, NDATA, G1, B1, ETA
      PRINT 41
      PRINT 62,XMAX
      PRINT 63,XMIN
      PRINT 65,W
      B = 0.5*AKURCY
      DO 22 I=1,K
      A=I
      CSV(I)= XMIN+(A-1.0)*W
      CEV(I)= CSV(I)+W-AKURCY
      CLB(I)= CSV(I)-B
      CUB(I) = CEV(I) +B
   22 CONTINUE
      CEV(K) = XMAX
      CUB(K) = CEV(K) +B
      DO 23 J=1,K
23    FREQ(J)=0.0
      DO 24 I=1,NDATA
      DO 24 J=1,K
      IF(X(I).GE.CLB(J).AND.X(I).LE.CUB(J)) FREQ(J) = FREQ(J) + 1.0
24    CONTINUE
C-----CHI-SQUARE TEST
      PRINT 406
      DO 30 I=1,K
      AREA(I) = 1.0 -EXP(-(((CUB(I)-G1)/ETA)**B1))
```

```
      IF (I .EQ. 1) GO TO 51
      IF (I .GT. 1 .AND. I .LT. K) GO TO 52
      REQAREA(K) = 1.0 - AREA(K)
      GO TO 30
   51 REQAREA(I) = AREA(I)
      GO TO 30
   52 REQAREA(I) = AREA(I) - AREA(I-1)
   30 CONTINUE
   76 DO 80 M = 1,K
      EXFREQ(M)=DATA*REQAREA(M)
      U(M)=(( EXFREQ(M)-FREQ(M))**2)/EXFREQ(M)
80    CHISQR=CHISQR+U(M)
C-----TO PRINT THE TABLE FOR CHI-SQUARE TEST
   88 DO 33 I = 1,K
33    PRINT 34,I,CLB(I),CUB(I), EXFREQ(I),FREQ(I),U(I)
      PRINT 35, CHISQR
62    FORMAT( 10X, 14HMAXIMUM VALUE=,F15.6)
63    FORMAT( 10X, 14HMINIMUM VALUE=, F15.6)
65    FORMAT( 10X, 12HCLASS WIDTH=, F17.6)
41    FORMAT(1H0)
406   FORMAT (8X,5H CELL,10X,10HLOWER CELL,11X,10HUPPER CELL,13X,8HEXPEC
     1TED,13X,8HOBSERVED,13X,11HCHI-SQUARED/8X,6HNUMBER,10X,8HBOUNDARY,
     213X, 8HBOUNDARY,13X,9HFREQUENCY,12X,9HFREQUENCY,12X,13HVALUE OF CE
     3LL/)
34    FORMAT (10X,I2,5F21.6)
35    FORMAT (1H0,81X,25HTOTAL CHI-SQUARED VALUE =,F10.6//)
  141 FORMAT (1H0,70X,*CHI-SQUARED TEST*,//)
  241 FORMAT(1H0,70X,*FIXED CELL WIDTHS*,//)
  177 FORMAT (1H0, 10X, *INPUTS = *,I10, 3F15.3,/)
   78 CONTINUE
      RETURN
      END
```

```
      SUBROUTINE CHISQB (X,NDATA,G1,B1,ETA,CHISQR)
      DIMENSION X(50),    CLB(9), CUB(9), REQAREA(9), AREA(9), FREQ(9),
     2EXFREQ(9), U(9)
C-----SUBROUTINE TO FIT A HISTOGRAM TO THE DATA AND PERFORM THE
C-----CHI-SQUARED TEST FOR THE WEIBULL DISTRIBUTION
      PRINT 341
      CHISQR = 0.0
      J = 0
      DO 26 K=5,NDATA,5
      J = J+1
      IF (K .LT. NDATA) CUB(J)=(X(K)+X(K+1))/2.0
      IF (K .EQ. 5) CLB(J)=X(1)
      IF (K .GT. 5 .AND. K .LT. NDATA) CLB (J)=CUB(J-1)
      L = (NDATA-K)
      IF(L.NE.0) AREA(J)=1.0-EXP(-(((CUB(J)-G1)/ETA)**B1))
      IF(L.EQ.0) AREA(J) =1.0
      FREQ(J)=5.0
      IF(J.EQ.1) REQAREA(J)=AREA(J)
      IF(J.GT.1.AND.L.NE.0) REQAREA(J)=AREA(J)-AREA(J-1)
      IF (L.LT.5) GO TO 27
      GO TO 26
   27 IF(L.NE.0) J=J+1
      CUB(J)=X(NDATA)
      CLB(J)=CUB(J-1)
      REQAREA(J)=1.0-AREA(J-1)
      IF( L .NE. 0) FREQ(J) = L
   26 CONTINUE
      I = J
      DO 25 J=1,I
      EXFREQ(J) = NDATA*REQAREA(J)
   25 CONTINUE
      K = I
   62 I = 1
 2420 IF (EXFREQ(I) .GE. 5.) GO TO 2430
      EXFREQ(I+1) = EXFREQ(I+1) + EXFREQ(I)
      FREQ(I+1) = FREQ(I+1) + FREQ(I)
      J = I
      DO 2425 L=1,J
      EXFREQ(L) = 0.
 2425 FREQ(L) = 0.
      I = I+1
      GO TO 2420
 2430 I = K
 2440 IF (EXFREQ(I) .GE. 5.) GO TO 2450
      EXFREQ(I-1) = EXFREQ(I-1)+EXFREQ(I)
      FREQ(I-1) = FREQ(I-1) + FREQ(I)
      DO 2445 L=I,K
      EXFREQ(L) = 0.
 2445 FREQ(L) = 0.
```

```
      I = I-1
      GO TO 2440
 2450 CONTINUE
      DO 85 M=1,K
      U(M) = 0.0
      IF (EXFREQ(M) .EQ. 0.) GO TO 85
      U(M) = ((EXFREQ(M) - FREQ(M))**2/EXFREQ(M))
   85 CONTINUE
      CHISQR = 0.0
      DO 90 M=1,K
   90 CHISQR = CHISQR + U(M)
      J = K
   88 DO 33 I = 1,J
   33 PRINT 34,I,CLB(I),CUB(I), EXFREQ(I),FREQ(I),U(I)
      PRINT 35, CHISQR
   34 FORMAT (10X,I2,5F21.6)
   35 FORMAT (1H0,81X,25HTOTAL CHI-SQUARED VALUE =,F10.6)
  341 FORMAT(1H0,65X,*VARIABLE CELL WIDTHS*,//)
   78 CONTINUE
      RETURN
      END
```

```
      SUBROUTINE GRAPH (FREQ,XMAX,XMIN,CLB,CUB,SKS,CHISQR,BETA,ETA,
     1 GAMMA,NDATA,K,CELLWD)
      DIMENSION FREQ(9),CLB(9),CUB(9)
      INTEGER FOOT(30),SUBTITL(2)
      LOGICAL NITIAL
      DATA NITIAL / .TRUE. /
C
C     READ PLOT CARD
C
      READ(2,400) IPLOT,SUBTITL,IPEN
  400 FORMAT(4A10)
      IF(EOF(2)) 999,3
    3 IF(IPLOT.NE.7HWEIBULL) GO TO 999
      IF(NITIAL) 4,5
    4 NITIAL = .FALSE.
      PEN = 0.3
      IF(IPEN .EQ. 10HBALL POINT) PEN = 0.0
      CALL INITIAL (0,1,PEN,0)
    5 READ (2,401) FOOT
  401 FORMAT(5A10)
C
C     DETERMINE DISTANCES
C
    2 XLENGTH = 6.0
      YLENGTH = 5.0
      H = 0.15
      YMAX = 0.0
      DO 1 I=1,K
      IF(YMAX.LT.FREQ(I)) YMAX=FREQ(I)
    1 CONTINUE
      FRINGE = 0.40*NDATA
      FRINL = 0.25*NDATA
      IF(YMAX .GE. FRINL .AND. YMAX .LT. FRINGE) GO TO 7
      IF(YMAX .GE. FRINGE) YMAX = IFIX(YMAX + FRINGE)
      GO TO 6
    7 YMAX = IFIX(YMAX + FRINL)
    6 CONTINUE
      I=YMAX
      IF((I/2*2).NE.I) YMAX=YMAX+1.
      XMIN = XMIN - 0.10 * (XMAX - XMIN)
      XDIF = XMAX - XMIN
C
C     DETERMINE SCALING FACTORS
C
      XSCALE = (XMAX - XMIN) / XLENGTH
      YSCALE = YMAX / YLENGTH
      E = IFIX(ALOG10(XMAX - XMIN))
      STP = 10.0 ** E
```

```
      CALL PLOT(XLENGTH+2.,0.,-3)
      CALL PLOT(0.,-11.,-3)
      CALL PLOT (0.,5.,-3)
C     CONSTRUCT Y-AXIS
C
      CALL PLOT (0.,YLENGTH,2)
      DIV=1./YSCALE
   21 IF(DIV.GE.(2.*H)) GO TO 22
      DIV=2.*DIV
      GO TO 21
   22 STEP=DIV
      YY=0.
   23 CALL PLOT (.05,YY,3)
      CALL PLOT (-.05,YY,2)
      YN=YY*YSCALE
      CALL NUMBER (-.3,YY,H,YN,0.,-1)
      YY=YY+STEP
      IF(YY.LE.(YLENGTH+.01)) GO TO 23
      YY=(YLENGTH-3.75)/2.
      IF (YY.LT.0.) YY=0.
      CALL SYMBOL (-.4,YY,H,30HFREQUENCY/CLASS INTERVAL WIDTH,90.,30)
C
C     CONSTRUCT, DRAW, AND LABEL X-AXIS
C
      CALL PLOT (0.,0.,3)
      XMIN=IFIX(XMIN/STP)
      XMAX = IFIX(XMAX / STP + 1.0)
      XDIF = XMAX - XMIN
      XSCALE = XDIF / XLENGTH * STP
      DIV=10.*XDIF/XLENGTH
      IF(XMIN.EQ.0.) GO TO 26
      CALL PLOT (.3,0.,2)
      CALL PLOT (.35,0.,3)
      CALL PLOT (XLENGTH,0.,2)
      CALL PLOT (.35,.05,3)
      CALL PLOT (.25,-.05,2)
      CALL PLOT (.3,-.05,3)
      CALL PLOT (.4,.05,2)
      GO TO 28
   26 CALL PLOT (XLENGTH,0.,2)
   28 IF(DIV.LT.12.7) GO TO 30
      DIV=DIV/10.
      GO TO 28
   30 DIV=DIV/10.
      IF(DIV.LT.0.2) DIV=DIV*10.
   32 CALL NUMBER (0.,-.2,H,0.,0.,0)
      XX=0.
      DO 35 I=1,25
      XX=XX+1./DIV
      IF(XX.GT.XLENGTH) 40,33
```

```
   33 CALL PLOT (XX,.05,3)
      CALL PLOT (XX,-.05,2)
      XN=XMIN+I*XDIF/(DIV*XLENGTH)
      CALL NUMBER (XX-.1,-.2,H,XN,0.,0)
   35 CONTINUE
   40 DO 41 I=1,2
      IF(SUBTITL(I).EQ.1H ) GO TO 42
   41 CONTINUE
      I=2
      GO TO 43
   42 I=I-1
   43 XX=(XLENGTH-I)/2.
      I=I*10
      CALL SYMBOL (XX,-.5,.15,SUBTITL(1),0.,I)
      IF(STP.LT.1.01) GO TO 48
      CALL WHERE (XX, YY, IFAKE)
      CALL SYMBOL (XX,-.5,H,5H X 10,0.,5)
      CALL WHERE (XX, YY, IFAKE)
      CALL NUMBER (XX+H,YY+.5*H,.5*H,E,0.,-1)
C
C     CONSTRUCT AND DRAW HISTOGRAM
C
   48 DO 50 I=1,K
      CLB(I)=((CLB(I)/STP)-XMIN)/(XSCALE/STP)
   50 CUB(I)=((CUB(I)/STP)-XMIN)/(XSCALE/STP)
   52 CALL PLOT (CLB(1),0.,3)
      DO 55 I=1,K
      Y=FREQ(I)/YSCALE
      CALL PLOT (CLB(I),Y,2)
      CALL PLOT (CUB(I),Y,2)
   54 CALL PLOT (CUB(I),0.,2)
   55 CONTINUE
C
C     COMPUTE AND DRAW NORMAL CURVE ONE POINT AT A TIME
C
   60 STEP = XDIF * STP / 150.0
      XX = XMIN * STP
      CALL PLOT(0.,0.,3)
      EACT = EXP(-BETA)
      CHK = EXP(-1.0)
      IF(BETA .LT. 1.0) YSCALE=YSCALE*EACT/CHK
      BE = BETA / ETA
      IDOIT = 2HNO
      DO 100 I = 1,150
      IF(GAMMA .GT. XX) GO TO 100
      Z = (XX - GAMMA) / ETA
      Y = BE * Z ** (BETA - 1.0) * EXP( - 1.0 * Z ** BETA)
```

```
      Y = Y / YSCALE * NDATA * CELLWD
      XU=(XX-XMIN*STP)/XSCALE
      IF(IDOIT .EQ. 2HNO) GO TO 90
      IF(XU.GT.20.) GO TO 100
      IF(XMIN.EQ.0.) 80,70
   70 IF(XU.GE.0.4) 80,90
   80 CALL PLOT (XU,Y,2)
      GO TO 100
   90 CALL PLOT (XU,Y,3)
      IDOIT = 3HYES
  100 XX=XX+STEP
C
C     OTHER ALPHA-NUMERIC COMMENTARY
C
  130 CALL PLOT(0.,-1.,-3)
      CALL SYMBOL (0.0,0.0,H,24HKOLMOGOROV-SMIRNOV TEST:,0.0,24)
      CALL WHERE (XX, YY, IFAKE)
      XX=XX+H
      CALL SYMBOL (0.0,-2.0*H,H,17HCHI-SQUARED TEST:,0.0,17)
      CALL SYMBOL (0.0,-4.0*H,H,21HWEIBULL SLOPE (BETA):,0.0,21)
      CALL SYMBOL (0.0,-6.0*H,H,21HMINIMUM LIFE (GAMMA):,0.0,21)
      CALL SYMBOL (0.0,-8.0*H,H,22HSCALE PARAMETER (ETA):,0.0,22)
      CALL NUMBER (XX,0.0,H,SKS,0.0,3)
      CALL NUMBER (XX,-2.0*H,H,CHISQR,0.0,3)
      CALL NUMBER (XX,-4.0*H,H,BETA,0.0,3)
      CALL NUMBER (XX,-6.0*H,H,GAMMA,0.0,-1)
      CALL NUMBER (XX,-8.0*H,H,ETA,0.0,-1)
      CALL SYMBOL(0.,-14.*H,H,FOOT(1),0.,50)
      CALL SYMBOL(0.,-16.*H,H,FOOT(6),0.,50)
      CALL SYMBOL(0.,-18.*H,H,FOOT(11),0.,50)
      CALL SYMBOL(0.,-20.*H,H,FOOT(16),0.,50)
      CALL SYMBOL(0.,-22.*H,H,FOOT(21),0.,50)
      CALL SYMBOL(0.,-24.*H,H,FOOT(26),0.,50)
      XX=(XLENGTH-3.75)/2.
      IF(XX.LT.0.) XX=0.
      CALL SYMBOL (XX,6.25,H,31HWEIBULL DISTRIBUTION PARAMETERS,0.0,31)
  999 RETURN
      END
```

APPENDIX E

PDP PROGRAM TO CALCULATE ENDURANCE STRENGTH
PARAMETERS FROM STAIRCASE TESTS

C-FOCAL, 1969

```
01.10 A "MINIMUM STRESS LEVEL", YP, !
01.20 A "STRESS INCREMENT", DP, !
01.30 A "NO OF SPECIMENS",  NS, !
01.40 T "IF TEST IS BASED ON FAILURES THE CODE IS 0", !
01.50 T "IF BASED ON SUCCESSES THE CODE IS 1", !
01.60 A "WHAT IS THE CODE?", Co, !
01.70 A "NO OF STRESS LEVELS IN TEST", I, !, !
01.74 S CU = 0
01.75 S A = 0
01.76 S B = 0
01.77 T "NO OF SPEC IN EACH LEVL STARTING FROM THE 2ND LOWEST", !
01.80 FOR J = 1, 1, I-1; DO 4.0

02.10 S SD = 1.62*DP*((NS*B-A+2)/NS 2+0.029)
02.20 IF (CO) 2.3,2.3,2.4
02.30 S MU = YP+DP*(A/NS-.5)
02.35 GOTO 2.7
02.40 S MU = YP+DP*(A/NS-.5)
02.70 T %10.03 "MEAN", MU, !, "STD DEV", SD, !
02.80 Q

04.10 A NI, !
04.20 S CU = CU+1
04.30 S A = A+CU*NI
04.40 S B = B+CU 2*NI
```

APPENDIX - F

PDP-8 PROGRAM TO FIND POINTS ON THE GERBER PARABOLA AND THE VON MISES-HENCKY ELLIPSE FOR A GIVEN MATERIAL AND STRESS RATIO

Symbols:

r_s = R = Stress ratio

S_u = SU = Mean of static ultimate strength

S_e = SE = Mean of endurance strength

S_{m_e} = ME = Mean stress corresponding to S_{v_e}.

S_{v_e} = SV = Stress vector mean on von Mises-Hencky ellipse for stress ratio, r_s.

S_{m_p} = MP = Mean stress corresponding to S_{v_p}.

S_{v_p} = SP = Stress vector mean on Gerber parabola for stress ratio, r_s.

```
01.10 A "STRESS RATIO", R, !
01.20 A "SU", SU, !
01.30 A "SE", SE, !
01.40 S A=FSQT((SE↑2)+(R↑2)*(SU↑2))
01.50 S ME=SU*SE/A
01.60 S AE=R*ME
01.70 S SV=FSQT((ME↑2)+(AE↑2))
01.80 S B=FSQT((R 2)*(SU↑4)/(SE↑2)+4*(SU↑2))
01.90 S MP=( -R/2)*((SU↑2)/SE)+B/2

02.10 S AP= R*MP
02.20 S SP=FSQT((AP↑2)+(MP↑2))
02.30 T % 9.5, ME, AE, SV,! MP, AP, SP,!!
02.40 GO TO 1.10
```

APPENDIX - G

PDP-8 PROGRAM TO FIND THE ESTIMATE OF THE MEAN STRENGTH, THE CORRESPONDING MEAN AND ALTERNATING LOADS, AND A SUITABLE MEAN LOAD INCREMENT USING THE VON MISES-HENCKY FAILURE CRITERION

```
* W A
C-FOCAL, 1969

01.10 A "DIAMETER",D,!
01.20 A "STRESS INCREMENT",IS,!
01.30 A "ULTIMATE STRENGTH",SU,!
01.40 A "ENDURANCE STRENGTH",SE,!
01.50 A "STRESS RATIO",R,!
01.60 S A=3.1416*(D↑2)/4
01.70 S SM=(SE*SU)/FSQT(((SU↑2)*(R↑2)) + (SE↑2))
01.80 S PM=SM*A

02.10 S IM=IS/FSQT(1 + (R↑2))
02.20 S IP = IM*A
02.30 T "  MEAN STRESS    STRESS INC  MEAN LOAD  LOAD INC.",!!
02.40 T %9.03, SM, IM, PM, IP,!!
02.50 GO TO 1.50
```

APPENDIX - H

PDP-8 PROGRAM TO FIND THE MEAN AND ALTERNATING LOAD STEPS FOR STRESS RATIOS, $r_S = \infty$, FOR STAIRCASE TESTING WITH THE AXIAL FATIGUE RELIABILITY RESEARCH MACHINE

Symbols:

S_v = Stress vector

S_n = Mean stress

S_a = Alternating stress

PM = Mean load

PA = Alternating load

```
*W A
C-FOCAL, 1969

01.10 A "DIAMETER",D,!
01.20 A "STRESS RATIO",R,!
01.25 A "MAX MEAN LOAD",PM,!
01.30 S A = 3.1416*D↑2/4
01.35 T A    SV    ","    SM    ","    PM    ","    SA   ","  PA",!

02.10 S PM = PM-1
02.15 S SM = PM/A
02.20 S SA = SM*R
02.25 S PA = SA*A
02.30 S SV = SM*FSQT(1+(R↑2))
02.40 T %9.03, SV, SM, PM, SA, PA,!!
02.50 GO TO 2.10
*
```

APPENDIX - I

PDP-8 PROGRAM TO CALCULATE THE LOAD FOR STAIRCASE TESTING AT THE STRESS RATIO, $r_s = \infty$, FOR THE AXIAL FATIGUE RELIABILITY RESEARCH MACHINE

```
*W A
C-FOCAL, 1969

01.10 A "DIAMETER",D,!
01.20 A "ULTIMATE STRENGTH",SU,!
01.30 A "STRESS INCREMENT",IS,!
01.35 S SM=0
01.40 S PM=0
01.45 S SE=0.45*SU
01.50 S A=3.1416*(D↑2)/4
01.55 S P=SE*A
01.60 S IPA=IS*A
01.65 T "LOAD",%9.03,P,!
01.70 T "LOAD INCREMENT",%9.03,IPA,!
01.75 A "ROUNDED ALT LOAD",P,!
01.80 A "ROUNDED ALT LOAD INC",PAI,!

02.10 S SA=P/A
02.20 S SI=PAI/A
02.30 S SA=SA+6*SI
02.40 S P=P+6*PAI
02.50 T "   DIA     SV     SA     PA     SM     PM",!!!
02.60 FOR I=1,1,11; DO 3.0

03.10 S SA=SA-SI
03.20 S P=P-PAI
03.30 S SV=SA
03.40 T %7.03, D, SV, SA, P, SM, PM,!!
```

8.0 DETAILED TEST DATA

This section contains the detailed test data which were used in the analyses discussed in Section 2 to determine the results and conclusions of Sections 3 and 4. Included are the calibration and experimental data for the Wire Fatigue Machines, Wiedemann Fatigue Machines, and the Axial Fatigue Machine.

8.1 WIRE FATIGUE MACHINE DATA

Table 8.1-1 Wire Fatigue Research Machines

FATIGUE RELIABILITY RESEARCH CALIBRATION DATA SHEET

Wire Fatigue Machine No. 1   Group No. 1

Wire Diameter .040 in.   Date Feb. 26, 1972

Material AISI 4340   Deflection Angle 4 deg.

Remarks:

NO.	Pan Weight	Axial Stress (P/A)	B.L.H. Strain Ind. Reading (reference)	B.L.H. Strain Ind. Reading	Measured Strain Micro in/in
1			1,250	1,390	140
2			1,295	1,435	140
3			1,295	1,420	125
4			1,295	1,435	140
5			1,295	1,435	140
6			1,305	1,450	145
7			1,305	1,430	125
8			1,305	1,445	140
9			1,305	1,445	140
10			1,310	1,450	140
		Mean Measured Strain =	137.5 μ-in/in.		

Table 8.1-1 Continued

FATIGUE RELIABILITY RESEARCH CALIBRATION DATA SHEET

Wire Fatigue Machine No. 1

Group No. 1

Wire Diameter .040 in.

Date Feb. 26, 1972

Material AISI 4340

Deflection Angle 8 deg.

Remarks:

NO.	Pan Weight	Axial Stress (P/A)	B.L.H. Strain Ind. Reading (reference)	B.L.H. Strain Ind. Reading	Measured Strain Micro in/in
1			1,250	1,545	295
2			1,295	1,585	290
3			1,295	1,565	270
4			1,295	1,580	285
5			1,295	1,580	285
6			1,305	1,585	280
7			1,305	1,570	265
8			1,305	1,590	285
9			1,305	1,575	270
10			1,310	1,590	280
		Mean Measured Strain =		280.5 μ-in/in	

Table 8.1-1 Continued

FATIGUE RELIABILITY RESEARCH CALIBRATION DATA SHEET

Wire Fatigue Machine No. 1 Group No. 1

Wire Diameter 40 in. Date Feb. 26, 1972

Material AISI 40 Deflection Angle 12 deg.

Remarks:

NO.	Pan Weight	Axial Stress (P/A)	B.L.H. Strain Ind. Reading (reference)	B.L.H. Strain Ind. Reading	Measured Strain Micro in/in
1			1,250	1,790	540
2			1,295	1,820	525
3			1,295	1,750	455
4			1,295	1,805	510
5			1,295	1,760	465
6			1,305	1,810	505
7			1,305	1,765	460
8			1,305	1,805	500
9			1,305	1,770	465
10			1,310	1,820	510
		Mean Measured Strain =		493.5 μ-in/in.	

Table 8.1-1 Continued

FATIGUE RELIABILITY RESEARCH CALIBRATION DATA SHEET

Wire Fatigue Machine No. 1 — Group No. 1

Wire Diameter .040 in. — Date Feb. 26, 1972

Material AISI 4340 — Deflection Angle 16 deg.

Remarks:

NO.	Pan Weight	Axial Stress (P/A)	B.L.H. Strain Ind. Reading (reference)	B.L.H. Strain Ind. Reading	Measured Strain Micro in/in
1			1,250	2,160	910
2			1,295	2,160	865
3			1,295	2,125	830
4			1,295	2,160	865
5			1,295	2,130	835
6			1,305	2,170	865
7			1,305	2,135	830
8			1,305	2,155	850
9			1,305	2,125	820
10			1,310	2,170	810
			Mean Measured	Strain = 848	μ-in/in.

Table 8.1-1 Continued

FATIGUE RELIABILITY RESEARCH CALIBRATION DATA SHEET

Wire Fatigue Machine No. 1 Group No. 1
Wire Diameter .040 in. Date Feb. 26, 1972
Material AISI 4340 Deflection Angle 18 deg.
Remarks:

NO.	Pan Weight	Axial Stress (P/A)	B.L.H. Strain Ind. Reading (reference)	B.L.H. Strain Ind. Reading	Measured Strain Micro in/in
1			1,250	2,335	1,085
2			1,295	2,330	1,035
3			1,295	2,300	1,005
4			1,295	2,325	1,030
5			1,295	2,315	1,020
6			1,305	2,335	1,030
7			1,305	2,310	1,005
8			1,305	2,305	1,000
9			1,305	2,315	1,010
10			1,310	2,340	1,030
			Mean Measured	Strain = 1,025	μ-in/in.

Table 8.1-1 Continued

FATIGUE RELIABILITY RESEARCH CALIBRATION DATA SHEET

Wire Fatigue Machine No. 1 Group No. 1

Wire Diameter .040 in. Date Feb. 26, 1972

Material AISI 4340 Deflection Angle 20 deg.

Remarks:

NO.	Pan Weight	Axial Stress (P/A)	B.L.H. Strain Ind. Reading (reference)	B.L.H. Strain Ind. Reading	Measured Strain Micro in/in
1			1,250	2,505	1,255
2			1,295	2,500	1,205
3			1,295	2,480	1,185
4			1,295	2,510	1,215
5			1,295	2,490	1,195
6			1,305	2,505	1,200
7			1,305	2,485	1,180
8			1,305	2,505	1,200
9			1,305	2,490	1,185
10			1,310	2,510	1,200
			Mean Measured	Strain 1,202	μ-in/in.

Table 8.1-1 Continued

FATIGUE RELIABILITY RESEARCH CALIBRATION DATA SHEET

Wire Fatigue Machine No. 1   Group No. 1

Wire Diameter .040 in.   Date Feb. 26, 1972

Material AISI 4340   Deflection Angle 22 deg.

Remarks:

NO.	Pan Weight	Axial Stress (P/A)	B.L.H. Strain Ind. Reading (reference)	B.L.H. Strain Ind. Reading	Measured Strain Micro in/in
1			1,250	2,675	1,425
2			1,295	2,660	1,365
3			1,295	2,655	1,360
4			1,295	2,665	1,370
5			1,295	2,655	1,360
6			1,305	2,670	1,365
7			1,305	2,650	1,345
8			1,305	2,660	1,355
9			1,305	2,655	1,350
10			1,310	2,670	1,360
			Mean Measured	Strain = 1365	.5 μ-in/in.

Table 8.1-1 Continued

FATIGUE RELIABILITY RESEARCH CALIBRATION DATA SHEET

Wire Fatigue Machine No. 1 Group No. 1

Wire Diameter .040 in. Date Feb. 26, 1972

Material AISI 4340 Deflection Angle 24 deg.

Remarks:

NO.	Pan Weight	Axial Stress (P/A)	B.L.H. Strain Ind. Reading (reference)	B.L.H. Strain Ind. Reading	Measured Strain Micro in/in
1			1,250	2,820	1,570
2			1,295	2,815	1,520
3			1,295	2,820	1,525
4			1,295	2,835	1,540
5			1,295	2,820	1,525
6			1,305	2,835	1,530
7			1,305	2,825	1,520
8			1,305	2,825	1,520
9			1,305	2,825	1,520
10			1,310	2,840	1,530
			Mean Measured	Strain 1,530	μ - in/in

Table 8.1-1 Continued

FATIGUE RELIABILITY RESEARCH CALIBRATION DATA SHEET

Wire Fatigue Machine No. 1   Group No. 1

Wire Diameter .040 in.   Date Feb. 26, 1972

Material AISI 4340   Deflection Angle 26 deg.

Remarks:

NO.	Pan Weight	Axial Stress (P/A)	B.L.H. Strain Ind. Reading (reference)	B.L.H. Strain Ind. Reading	Measured Strain Micro in/in
1			1,250	2,980	1,730
2			1,295	2,980	1,685
3			1,295	2,985	1,690
4			1,295	2,985	1,690
5			1,295	2,985	1,690
6			1,305	2,985	1,680
7			1,305	2,990	1,635
8			1,305	2,940	1,635
9			1,305	2,985	1,680
10			1,310	2,985	1,675
			Mean Measured	Strain 1,679	μ - in/in.

Table 8.1-2 Wire Fatigue Research Machines

FATIGUE RELIABILITY RESEARCH CALIBRATION DATA SHEET

Wire Fatigue Machine No. 2 Group No. 2

Wire Diameter .040 in. Date Feb. 26, 1972

Material AISI 4340 Steel Deflection Angle 4 deg.

Remarks:

NO.	Pan Weight	Axial Stress (P/A)	B.L.H. Strain Ind. Reading (reference)	B.L.H. Strain Ind. Reading	Measured Strain Micro in/in
1			1,060	1,145	85
2			1,110	1,250	140
3			1,110	1,240	130
4			1,120	1,250	130
5			1,120	1,250	130
6			1,115	1,260	145
7			1,115	1,240	125
8			1,105	1,255	150
9			1,105	1,225	120
10			1,100	1,240	140
			Mean Measured	Strain = 116.	5 μ - in/in.

Table 8.1-2 Continued

FATIGUE RELIABILITY RESEARCH CALIBRATION DATA SHEET

Wire Fatigue Machine No. 2
Wire Diameter .040 in.
Material AISI 4340 Steel
Remarks:

Group No. 2
Date Feb. 26, 1972
Deflection Angle 8 deg.

NO.	Pan Weight	Axial Stress (P/A)	B.L.H. Strain Ind. Reading (reference)	B.L.H. Strain Ind. Reading	Measured Strain Micro in/in
1			1,060	1,310	250
2			1,110	1,420	310
3			1,110	1,385	275
4			1,120	1,400	280
5			1,120	1,390	270
6			1,115	1,400	285
7			1,115	1,370	255
8			1,105	1,400	295
9			1,105	1,355	250
10			1,100	1,375	275
			Mean Measured	Strain = 274.5	μ - in/in.

Table 8 .1-2 Continued

FATIGUE RELIABILITY RESEARCH CALIBRATION DATA SHEET

Wire Fatigue Machine No. 2 Group No. 2

Wire Diameter .040 in. Date Feb. 26, 1972

Material AISI 4340 Steel Deflection Angle 12 deg.

Remarks:

NO.	Pan Weight	Axial Stress (P/A)	B.L.H. Strain Ind. Reading (reference)	B.L.H. Strain Ind. Reading	Measured Strain Micro in/in
1			1,060	1,665	605
2			1,110	1,760	650
3			1,110	1,715	605
4			1,120	1,775	655
5			1,120	1,705	585
6			1,115	1,780	665
7			1,115	1,725	610
8			1,105	1,720	615
9			1,105	1,690	585
10			1,100	1,735	635
			Mean Measured	Strain = 621	μ - in/in.

Table 8.1-2 Continued

FATIGUE RELIABILITY RESEARCH CALIBRATION DATA SHEET

Wire Fatigue Machine No. 2 Group No. 2

Wire Diameter .040 in. Date Feb. 26, 1972

Material AISI 4340 Steel Deflection Angle 16 deg.

Remarks:

NO.	Pan Weight	Axial Stress (P/A)	B.L.H. Strain Ind. Reading (reference)	B.L.H. Strain Ind. Reading	Measured Strain Micro in/in
1			1,060	2,050	990
2			1,110	2,140	1,030
3			1,110	2,095	985
4			1,120	2,155	1,035
5			1,120	2,090	970
6			1,115	2,115	1,000
7			1,115	2,110	995
8			1,105	2,110	1,005
9			1,105	2,065	960
10			1,100	2,140	1,040
			Mean Measured	Strain = 1,001 μ - in/in.	

Table 8.1-2 Continued

FATIGUE RELIABILITY RESEARCH CALIBRATION DATA SHEET

Wire Fatigue Machine No. 2 Group No. 2

Wire Diameter .040 in. Date Feb. 26, 1972

Material AISI 4340 Steel Deflection Angle 18 deg.

Remarks:

NO.	Pan Weight	Axial Stress (P/A)	B.L.H. Strain Ind. Reading (reference)	B.L.H. Strain Ind. Reading	Measured Strain Micro in/in
1			1,060	2,235	1,175
2			1,110	2,310	1,200
3			1,110	2,275	1,165
4			1,120	2,320	1,200
5			1,120	2,265	1,145
6			1,115	2,320	1,205
7			1,115	2,285	1,170
8			1,105	2,275	1,170
9			1,105	2,240	1,135
10			1,100	2,290	1,190

Mean Measured Strain = 1,175.5 μ - in/in.

Table 8.1-2 Continued

FATIGUE RELIABILITY RESEARCH CALIBRATION DATA SHEET

Wire Fatigue Machine No. 2 Group No. 2

Wire Diameter .040 in. Date Feb. 26, 1972

Material AISI 4340 Steel Deflection Angle 20 deg.

Remarks:

NO.	Pan Weight	Axial Stress (P/A)	B.L.H. Strain Ind. Reading (reference)	B.L.H. Strain Ind. Reading	Measured Strain Micro in/in
1			1,060	2,425	1,365
2			1,110	2,485	1,375
3			1,110	2,450	1,340
4			1,120	2,480	1,360
5			1,120	2,450	1,330
6			1,115	2,470	1,355
7			1,115	2,465	1,350
8			1,105	2,435	1,330
9			1,105	2,415	1,305
10			1,100	2,450	1,350
			Mean Measured	Strain = 1,346 μ - in/in.	

Table 8.1-2 Continued

FATIGUE RELIABILITY RESEARCH CALIBRATION DATA SHEET

Wire Fatigue Machine No. 2 Group No. 2
Wire Diameter .040 in. Date Feb. 26, 1972
Material AISI 4340 Steel Deflection Angle 22 deg.
Remarks:

NO.	Pan Weight	Axial Stress (P/A)	B.L.H. Strain Ind. Reading (reference)	B.L.H. Strain Ind. Reading	Measured Strain Micro in/in
1			1,060	2,595	1,535
2			1,110	2,630	1,520
3			1,110	2,630	1,520
4			1,120	2,640	1,520
5			1,120	2,635	1,515
6			1,115	2,650	1,535
7			1,115	2,625	1,510
8			1,105	2,610	1,505
9			1,105	2,600	1,495
10			1,100	2,615	1,515
			Mean Measured	Strain = 1,517 μ - in/in.	

Table 8.1-2 Continued

FATIGUE RELIABILITY RESEARCH CALIBRATION DATA SHEET

Wire Fatigue Machine No. 2 | Group No. 2
Wire Diameter .040 in. | Date Feb. 26, 1972
Material AISI 4340 Steel | Deflection Angle 24 deg.
Remarks:

NO.	Pan Weight	Axial Stress (P/A)	B.L.H. Strain Ind. Reading (reference)	B.L.H. Strain Ind. Reading	Measured Strain Micro in/in
1			1,060	2,765	1,705
2			1,110	2,800	1,690
3			1,110	2,800	1,690
4			1,120	2,810	1,690
5			1,120	2,810	1,690
6			1,115	2,820	1,705
7			1,115	2,790	1,675
8			1,105	2,760	1,655
9			1,105	2,775	1,670
10			1,100	2,290	1,690

Mean Measured Strain = 1,686 μ - in/in.

Table 8.1-2 Continued

FATIGUE RELIABILITY RESEARCH CALIBRATION DATA SHEET

Wire Fatigue Machine No. 2 Group No. 2

Wire Diameter .040 in. Date Feb. 26, 1972

Material AISI 4340 Steel Deflection Angle 26 deg.

Remarks:

NO.	Pan Weight	Axial Stress (P/A)	B.L.H. Strain Ind. Reading (reference)	B.L.H. Strain Ind. Reading	Measured Strain Micro in/in
1			1,060	2,915	1,855
2			1,110	2,915	1,805
3			1,110	2,945	1,835
4			1,120	2,945	1,825
5			1,120	2,965	1,845
6			1,115	2,965	1,850
7			1,115	2,965	1,850
8			1,105	2,965	1,860
9			1,105	2,910	1,805
10			1,100	2,910	1,810
			Mean Measured	Strain = 1,834 μ -	in/in.

Table 8.1-3 Wire Fatigue Research Machines

FATIGUE RELIABILITY RESEARCH CALIBRATION DATA SHEET

Wire Fatigue Machine No. 3 Group No. 3

Wire Diameter .040 in. Date Feb. 26, 1972

Material AISI 4340 Steel Deflection Angle 4 deg.

Remarks:

NO.	Pan Weight	Axial Stress (P/A)	B.L.H. Strain Ind. Reading (reference)	B.L.H. Strain Ind. Reading	Measured Strain Micro in/in
1			1,330	1,460	130
2			1,385	1,530	145
3			1,385	1,525	140
4			1,405	1,545	140
5			1,405	1,540	135
6			1,415	1,555	140
7			1,415	1,545	130
8			1,420	1,565	145
9			1,420	1,555	135
10			1,420	1,570	150
			Mean Measured	Strain = 139	μ - in/in.

Table 8.1-3 Continued

FATIGUE RELIABILITY RESEARCH CALIBRATION DATA SHEET

Wire Fatigue Machine No. 3 Group No. 3

Wire Diameter .040 in. Date Feb. 26, 1972

Material AISI 4340 Steel Deflection Angle 8 deg.

Remarks:

NO.	Pan Weight	Axial Stress (P/A)	B.L.H. Strain Ind. Reading (reference)	B.L.H. Strain Ind. Reading	Measured Strain Micro in/in
1			1,330	1,700	370
2			1,385	1,725	340
3			1,385	1,700	315
4			1,405	1,740	335
5			1,405	1,700	295
6			1,415	1,750	335
7			1,415	1,695	280
8			1,420	1,750	330
9			1,420	1,715	295
10			1,420	1,755	335
			Mean Measured	Strain = 323	μ - in/in.

Table 8.1-3 Continued

FATIGUE RELIABILITY RESEARCH CALIBRATION DATA SHEET

Wire Fatigue Machine No. 3
Group No. 3
Wire Diameter .040 in.
Date Feb. 26, 1972
Material AISI 4340 Steel
Deflection Angle 12 deg.
Remarks:

NO.	Pan Weight	Axial Stress (P/A)	B.L.H. Strain Ind. Reading (reference)	B.L.H. Strain Ind. Reading	Measured Strain Micro in/in
1			1,330	2,075	745
2			1,385	2,080	695
3			1,385	2,065	680
4			1,405	2,080	675
5			1,405	2,070	665
6			1,415	2,100	675
7			1,415	2,075	660
8			1,420	2,095	675
9			1,420	2,080	660
10			1,420	2,100	680
			Mean Measured	Strain = 681	μ- in/in.

Table 8.1-3 Continued

FATIGUE RELIABILITY RESEARCH CALIBRATION DATA SHEET

Wire Fatigue Machine No. 3   Group No. 3

Wire Diameter .040 in.   Date Feb. 26, 1972

Material AISI 4340 Steel   Deflection Angle 16 deg.

Remarks:

NO.	Pan Weight	Axial Stress (P/A)	B.L.H. Strain Ind. Reading (reference)	B.L.H. Strain Ind. Reading	Measured Strain Micro in/in
1			1,330	2,395	1,065
2			1,385	2,410	1,025
3			1,385	2,400	1,015
4			1,405	2,415	1,010
5			1,405	2,410	1,005
6			1,415	2,420	1,005
7			1,415	2,410	995
8			1,420	2,430	1,010
9			1,420	2,410	990
10			1,420	2,425	1,005
			Mean Measured	Strain = 1,012.5 μ - in/in.	

Table 8.1-3 Continued

FATIGUE RELIABILITY RESEARCH CALIBRATION DATA SHEET

Wire Fatigue Machine No. 3 Group No. 3
Wire Diameter .040 in. Date Feb. 26, 1972
Material AISI 4340 Steel Deflection Angle 18 deg.
Remarks:

NO.	Pan Weight	Axial Stress (P/A)	B.L.H. Strain Ind. Reading (reference)	B.L.H. Strain Ind. Reading	Measured Strain Micro in/in
1			1,330	2,550	1,220
2			1,385	2,570	1,185
3			1,385	2,565	1,180
4			1,405	2,575	1,170
5			1,405	2,575	1,170
6			1,415	2,580	1,165
7			1,415	2,570	1,155
8			1,420	2,585	1,165
9			1,420	2,585	1,165
10			1,420	2,595	1,175
			Mean Measured	Strain = 1,175 μ - in/in.	

Table 8.1-3 Continued

FATIGUE RELIABILITY RESEARCH CALIBRATION DATA SHEET

Wire Fatigue Machine No. 3 Group No. 3

Wire Diameter .040 in. Date Feb. 26, 1972

Material AISI 4340 Steel Deflection Angle 20 deg.

Remarks:

NO.	Pan Weight	Axial Stress (P/A)	B.L.H. Strain Ind. Reading (reference)	B.L.H. Strain Ind. Reading	Measured Strain Micro in/in
1			1,330	2,725	1,395
2			1,385	2,740	1,355
3			1,385	2,730	1,345
4			1,405	2,740	1,335
5			1,405	2,745	1,340
6			1,415	2,750	1,335
7			1,415	2,740	1,325
8			1,420	2,750	1,330
9			1,420	2,750	1,330
10			1,420	2,755	1,335
			Mean Measured	Strain = 1,342.5 μ - in/in.	

Table 8.1-3 Continued

FATIGUE RELIABILITY RESEARCH CALIBRATION DATA SHEET

Wire Fatigue Machine No. 3 Group No. 3

Wire Diameter .040 in. Date Feb. 26, 1972

Material AISI 4340 Steel Deflection Angle 22 deg.

Remarks:

NO.	Pan Weight	Axial Stress (P/A)	B.L.H. Strain Ind. Reading (reference)	B.L.H. Strain Ind. Reading	Measured Strain Micro in/in
1			1,330	2,890	1,560
2			1,385	2,900	1,515
3			1,385	2,890	1,505
4			1,405	2,895	1,490
5			1,405	2,900	1,495
6			1,415	2,905	1,490
7			1,415	2,900	1,485
8			1,420	2,910	1,490
9			1,420	2,905	1,485
10			1,420	2,915	1,495
			Mean Measured	Strain = 1,501 μ - in/in.	

Table 8.1-3 Continued

FATIGUE RELIABILITY RESEARCH CALIBRATION DATA SHEET

Wire Fatigue Machine No. 3 Group No. 3

Wire Diameter .040 in. Date Feb. 26, 1972

Material AISI 4340 Steel Deflection Angle 24 deg.

Remarks:

NO.	Pan Weight	Axial Stress (P/A)	B.L.H. Strain Ind. Reading (reference)	B.L.H. Strain Ind. Reading	Measured Strain Micro in/in
1			1,330	3,045	1,715
2			1,385	3,065	1,680
3			1,385	3,050	1,665
4			1,405	3,060	1,655
5			1,405	3,060	1,655
6			1,415	3,070	1,655
7			1,415	3,060	1,645
8			1,420	3,065	1,645
9			1,420	3,075	1,655
10			1,420	3,080	1,660
			Mean Measured	Strain = 1,663 μ - in/in.	

Table 8.1-3 Continued

FATIGUE RELIABILITY RESEARCH CALIBRATION DATA SHEET

Wire Fatigue Machine No. 3
Group No. 3
Wire Diameter .040 in.
Date Feb. 26, 1972
Material AISI 4340 Steel
Deflection Angle 26 deg.
Remarks:

NO.	Pan Weight	Axial Stress (P/A)	B.L.H. Strain Ind. Reading (reference)	B.L.H. Strain Ind. Reading	Measured Strain Micro in/in
1			1,330	3,210	1,880
2			1,385	3,210	1,825
3			1,385	3,200	1,815
4			1,405	3,200	1,795
5			1,405	3,220	1,815
6			1,415	3,220	1,805
7			1,415	3,215	1,800
8			1,420	3,215	1,795
9			1,420	3,225	1,805
10			1,420	3,225	1,805
			Mean Measured	Strain = 1,8	14 μ - in/in.

Table 8.1-4 Wire Fatigue Research Machines

FATIGUE RELIABILITY RESEARCH CALIBRATION DATA SHEET

Wire Fatigue Machine No. 4 Group No. 4

Wire Diameter .040 in. Date Feb. 26, 1972

Material AISI 4340 Steel Deflection Angle 4 deg.

Remarks:

NO.	Pan Weight	Axial Stress (P/A)	B.L.H. Strain Ind. Reading (reference)	B.L.H. Strain Ind. Reading	Measured Strain Micro in/in
1			1,210	1,335	125
2			1,280	1,395	115
3			1,280	1,385	105
4			1,295	1,410	115
5			1,295	1,405	110
6			1,300	1,415	115
7			1,300	1,410	110
8			1,310	1,420	110
9			1,310	1,410	100
10			1,310	1,420	110
			Mean Measured	Strain = 111.5 μ in/in.	

Table 8.1-4 Continued

FATIGUE RELIABILITY RESEARCH CALIBRATION DATA SHEET

Wire Fatigue Machine No. 4 Group No. 4
Wire Diameter .040 in. Date Feb. 26, 1972
Material AISI 4340 Steel Deflection Angle 8 deg.
Remarks:

NO.	Pan Weight	Axial Stress (P/A)	B.L.H. Strain Ind. Reading (reference)	B.L.H. Strain Ind. Reading	Measured Strain Micro in/in
1			1,210	1,485	275
2			1,280	1,535	255
3			1,280	1,560	280
4			1,295	1,550	255
5			1,295	1,565	270
6			1,300	1,550	250
7			1,300	1,555	255
8			1,310	1,560	250
9			1,310	1,580	270
10			1,310	1,555	245
			Mean Measured	Strain = 260.	5 μ - in/in.

Table 8.1-4 Continued

FATIGUE RELIABILITY RESEARCH CALIBRATION DATA SHEET

Wire Fatigue Machine No. 4 Group No. 4
Wire Diameter .040 in. Date ~~Feb. 26, 1972~~
Material AISI 4340 Steel Deflection Angle 12 deg.
Remarks:

NO.	Pan Weight	Axial Stress (P/A)	B.L.H. Strain Ind. Reading (reference)	B.L.H. Strain Ind. Reading	Measured Strain Micro in/in
1			1,210	1,780	570
2			1,280	1,825	545
3			1,280	1,815	535
4			1,295	1,860	565
5			1,295	1,830	535
6			1,300	1,860	560
7			1,300	1,835	535
8			1,310	1,860	550
9			1,310	1,840	530
10			1,310	1,860	540
			Mean Measured	Strain = 546.	5 μ - in/in.

Table 8.1-4 Continued

FATIGUE RELIABILITY RESEARCH CALIBRATION DATA SHEET

Wire Fatigue Machine No. 4 Group No. 4
Wire Diameter .040 in. Date Feb. 26, 1972
Material AISI 4340 Steel Deflection Angle 16 deg.
Remarks:

NO.	Pan Weight	Axial Stress (P/A)	B.L.H. Strain Ind. Reading (reference)	B.L.H. Strain Ind. Reading	Measured Strain Micro in/in
1			1,210	2,130	920
2			1,280	2,155	875
3			1,280	2,160	880
4			1,295	2,170	875
5			1,295	2,175	880
6			1,300	2,175	875
7			1,300	2,175	875
8			1,310	2,190	880
9			1,310	2,180	870
10			1,310	2,180	870
			Mean Measured	Strain = 880	μ - in/in.

Table 8.1-4 Continued

FATIGUE RELIABILITY RESEARCH CALIBRATION DATA SHEET

Wire Fatigue Machine No. 4 Group No. 4

Wire Diameter .040 in. Date Feb. 26, 1972

Material AISI 4340 Steel Deflection Angle 18 deg.

Remarks:

NO.	Pan Weight	Axial Stress (P/A)	B.L.H. Strain Ind. Reading (reference)	B.L.H. Strain Ind. Reading	Measured Strain Micro in/in
1			1,210	2,295	1,085
2			1,280	2,335	1,055
3			1,280	2,355	1,075
4			1,295	2,355	1,060
5			1,295	2,330	1,035
6			1,300	2,360	1,060
7			1,300	2,340	1,040
8			1,310	2,375	1,065
9			1,310	2,345	1,035
10			1,310	2,365	1,055

Mean Measured Strain = 1056.5 μ- in/in.

Table 8.1-4 Continued

FATIGUE RELIABILITY RESEARCH CALIBRATION DATA SHEET

Wire Fatigue Machine No. 4 Group No. 4
Wire Diameter .040 in. Date Feb. 26, 1972
Material AISI 4340 Steel Deflection Angle 20 deg.
Remarks:

NO.	Pan Weight	Axial Stress (P/A)	B.L.H. Strain Ind. Reading (reference)	B.L.H. Strain Ind. Reading	Measured Strain Micro in/in
1			1,210	2,460	1,250
2			1,280	2,500	1,220
3			1,280	2,510	1,230
4			1,295	2,525	1,230
5			1,295	2,500	1,205
6			1,300	2,520	1,220
7			1,300	2,495	1,195
8			1,310	2,535	1,225
9			1,310	2,510	1,200
10			1,310	2,525	1,215
			Mean Measured	Strain = 1219	μ in/in.

Table 8.1-4 Continued

FATIGUE RELIABILITY RESEARCH CALIBRATION DATA SHEET

Wire Fatigue Machine No. 4 Group No. 4

Wire Diameter .040 in. Date Feb. 26, 1972

Material AISI 4340 Steel Deflection Angle 22 deg.

Remarks:

NO.	Pan Weight	Axial Stress (P/A)	B.L.H. Strain Ind. Reading (reference)	B.L.H. Strain Ind. Reading	Measured Strain Micro in/in
1			1,210	2,630	1,420
2			1,280	2,650	1,370
3			1,280	2,665	1,385
4			1,295	2,675	1,380
5			1,295	2,650	1,355
6			1,300	2,670	1,370
7			1,300	2,665	1,365
8			1,310	2,690	1,380
9			1,310	2,665	1,355
10			1,310	2,675	1,365
			Mean Measured	Strain = 1374	.5 μ - in/in.

Table 8.1-4 Continued

FATIGUE RELIABILITY RESEARCH CALIBRATION DATA SHEET

Wire Fatigue Machine No. 4 Group No. 4

Wire Diameter .040 in. Date Feb. 26, 1972

Material AISI 4340 Steel Deflection Angle 24 deg.

Remarks:

NO.	Pan Weight	Axial Stress (P/A)	B.L.H. Strain Ind. Reading (reference)	B.L.H. Strain Ind. Reading	Measured Strain Micro in/in
1			1,210	2,800	1,590
2			1,280	2,815	1,535
3			1,280	2,830	1,550
4			1,295	2,835	1,540
5			1,295	2,820	1,525
6			1,300	2,835	1,535
7			1,300	2,825	1,525
8			1,310	2,850	1,540
9			1,310	2,835	1,525
10			1,310	2,840	1,530

Mean Measured Strain = 1539.5 μ - in/in.

Table 8.1-4 Continued

FATIGUE RELIABILITY RESEARCH CALIBRATION DATA SHEET

Wire Fatigue Machine No. 4   Group No. 4

Wire Diameter .040 in.   Date Feb. 26, 1972

Material AISI 4340 Steel   Deflection Angle 26 deg.

Remarks:

NO.	Pan Weight	Axial Stress (P/A)	B.L.H. Strain Ind. Reading (reference)	B.L.H. Strain Ind. Reading	Measured Strain Micro in/in
1			1,210	2,950	1,740
2			1,280	2,950	1,670
3			1,280	2,990	1,710
4			1,295	2,990	1,695
5			1,295	2,980	1,685
6			1,300	2,980	1,680
7			1,300	3,010	1,710
8			1,310	3,010	1,700
9			1,310	2,995	1,685
10			1,310	2,995	1,685
			Mean Measured	Strain = 1696	μ - in/in

Table 8.1-5 Static Calibration Data for Wire Fatigue Research Machine Calibration Specimen

FATIGUE RELIABILITY RESEARCH CALIBRATION DATA SHEET

Wire Fatigue Machine No.______ Group No. 1

Wire Diameter .040 in. Date 12/13/71

Material AISI 4340 Steel Deflection Angle ______ deg.

Remarks: Static Axial Load Test for Calibration Specimen

NO.	Pan Weight	Axial Stress (P/A)	B.L.H. Strain Ind. Reading (reference)	B.L.H. Strain Ind. Reading	Measured Strain Micro in/in
1	0.00	0.00	3804	----	0.00
2	7.00	5,573	3804	3830	26
3	10.50	8,360	3804	3875	71
4	14.00	11,146	3804	3921	117
5	17.50	13.933	3804	3972	168
6	21.00	16,720	3804	4019	215
7	24.50	19,506	3804	4069	265
8	28.00	22,293	3804	4121	317
9	31.50	25,080	3804	4175	371
10	35.00	27,866	3804	4227	423
11	35.00	27,866	3801	4227	426
12	31.50	25,080	3801	4175	374
13	28.00	22,293	3801	4124	323
14	24.50	19,506	3801	4073	272
15	21.00	16,720	3801	4023	222
16	17.50	13,933	3801	3975	174
17	14.00	11,146	3801	3922	121
18	10.50	8,360	3801	3870	69
19	7.00	5,573	3801	3829	28
20	0.00	0	3801	----	0.00

Table 8.1-5 Continued

FATIGUE RELIABILITY RESEARCH CALIBRATION DATA SHEET

Wire Fatigue Machine No._____ Group No. 2

Wire Diameter .040 in. Date 12/13/71

Material AISI 4340 Steel Deflection Angle _____ deg.

Remarks: Static Axial Load Test for Calibration Specimen

NO.	Pan Weight	Axial Stress (P/A)	B.L.H. Strain Ind. Reading (reference)	B.L.H. Strain Ind. Reading	Measured Strain Micro in/in
1	0.00	0.00	3802	----	0.00
2	7.00	5,573	3802	3827	25
3	10.50	8,360	3802	3869	67
4	14.00	11,146	3802	3918	116
5	17.50	13,933	3802	3968	166
6	21.00	16,720	3802	4015	213
7	24.50	19,506	3802	4062	260
8	28.00	22,293	3802	4118	316
9	31.50	25,080	3802	4170	368
10	35.00	27,866	3802	4222	420
11	35.00	27,866	3798	4222	424
12	31.50	25,080	3798	4170	372
13	28.00	22,293	3798	4118	320
14	24.50	19,506	3798	4070	272
15	21.00	16,720	3798	4017	219
16	17.50	13,933	3798	3968	170
17	14.00	11,146	3798	3916	118
18	10.50	8,360	3798	3870	72
19	7.00	5,573	3798	3825	27
20	0.00	0	3798	----	0.00

Table 8.1-5 Continued

FATIGUE RELIABILITY RESEARCH CALIBRATION DATA SHEET

Wire Fatigue Machine No._____ Group No. 3
Wire Diameter .040 in. Date 12/14/71
Material AISI 4340 Steel Deflection Angle _____ deg.
Remarks: Static Axial Load Test for Calibration Specimen

NO.	Pan Weight	Axial Stress (P/A)	B.L.H. Strain Ind. Reading (reference)	B.L.H. Strain Ind. Reading	Measured Strain Micro in/in
1	0.00	0.00	3810	----	0.00
2	7.00	5,573	3810	3835	25
3	10.50	8,360	3810	3879	69
4	14.00	11,146	3810	3925	115
5	17.50	13,933	3810	3975	165
6	21.00	16,720	3810	4022	212
7	24.50	19,506	3810	4071	261
8	28.00	22,293	3810	4121	311
9	31.50	25,080	3810	4174	364
10	35.00	27,866	3810	4221	411
11	35.00	27,866	3800	4225	414
12	31.50	25,080	3800	4174	374
13	28.00	22,293	3800	4121	321
14	24.50	19,506	3800	4072	272
15	21.00	16,720	3800	4023	223
16	17.50	13,933	3800	3973	173
17	14.00	11,146	3800	3972	122
18	10.50	8,360	3800	3875	75
19	7.00	5,573	3800	3829	29
20	0.00	0.00	3800	----	0.00

Table 8.1-5 Continued

FATIGUE RELIABILITY RESEARCH CALIBRATION DATA SHEET

Wire Fatigue Machine No.______ Group No. 4

Wire Diameter .040 in. Date 12/14/71

Material AISI 4340 Steel Deflection Angle______deg.

Remarks: Static Axial Load Test for Calibration Specimen

NO.	Pan Weight	Axial Stress (P/A)	B.L.H. Strain Ind. Reading (reference)	B.L.H. Strain Ind. Reading	Measured Strain Micro in/in
1	0.00	0.00	3800	----	0.00
2	7.00	5,573	3800	3828	28
3	10.50	8,360	3800	3875	75
4	14.00	11,146	3800	3921	121
5	17.50	13,933	3800	3969	169
6	21.00	16,720	3800	4018	218
7	24.50	19,506	3800	4070	270
8	28.00	22,293	3800	4120	320
9	31.50	25,080	3800	4174	374
10	35.00	27,866	3800	4226	426
11	35.00	27,866	3796	4226	430
12	31.50	25,080	3796	4174	378
13	28.00	22,293	3796	4120	324
14	24.50	19,506	3796	4072	276
15	21.00	16,720	3796	4021	225
16	17.50	13,933	3796	3970	174
17	14.00	11,146	3796	3918	122
18	10.50	8,360	3796	3872	76
19	7.00	5,573	3796	3825	29
20	0.00	0.00	3796	----	0.000

Table 8.1-6 Cycles-to-Failure Data of Group No. 129 Using Wire Fatigue Machine No. 1 for 35 Specimens of .040 in. Diameter AISI 4130 Steel Wire. Fixed Alternating Stress Level of 67.7 Kpsi. Bend Angle 19.5 Coast-Down Cycles 200 .*

Operator: Chet Nolf

Date of Test	Spec. No.	Cycles-to-Failure	Break Length from Scribed End inches	Remarks
May 1	1	732,700	4.5469	
2	2	408,400	4.4531	
2	3	465,400	4.4219	
2	4	726,500	4.5312	
3	5	400,300	4.3594	
3	6	365,100	4.3750	
4	7	1,371,400	4.5312	
5	8	1,152,700	4.0000	
8	9	571,700	4.9062	
8	10	384,500	4.5625	
9	11	158,300	4.9688	
9	12	511,200	4.5000	
9	13	940,500	4.5625	
10	14	940,400	5.1250	
10	15	505,200	4.1875	
10	16	1,376,600	4.4062	
12	17	456,900	4.2031	
12	18	608,300	4.6562	
15	19	643,000	4.5438	
15	20	483,900	4.5938	
15	21	715,200	4.0000	
15	22	270,600	4.9219	
15	23	372,300	4.7188	
16	24	395,900	5.0625	
16	25	831,400	4.6250	

* Subract from counter reading 200 cycles and enter in "Cycles to Failure" column.

Table 8.1-6 Cycles-to-Failure Data of Group No. 129 Using Wire Fatigue Machine No. 1 for 35 Specimens of .040 in. Diameter AISI 4130 Steel Wire. Fixed Alternating Stress Level of 67.7 Kpsi. Bend Angle 19.5 . Coast-Down Cycles 200 .*

Operator: Chet Nolf

Date of Test	Spec. No.	Cycles-to-Failure	Break Length from Scribed End inches	Remarks
19	26	855,600	4.3438	
22	27	545,800	5.2814	
23	28	1,218,200	4.3906	
24	29	1,463,500	4.7657	
25	30	957,300	4.8281	
26	31	832,800	4.0938	
26	32	1,225,800	4.0625	
30	33	615,300	4.0781	
30	34	1,447,500	4.4219	
31	35	1,677,300	4.3281	

* Subract from counter reading 200 cycles and enter in "Cycles to Failure" column.

Table 8.1-7 Cycles-to-Failure Data of Group No. 130 Using Wire Fatigue Machine No. 1 for 35 Specimens of .040 in. Diameter AISI 4130 Steel Wire. Fixed Alternating Stress Level of 70,000 psi. Bend Angle 20.° Coast-Down Cycles 200 .*

Operator: Chet Nolf

Date of Test	Spec. No.	Cycles-to-Failure	Break Length from Scribed End inches	Remarks
July 1	1	419,600	4.0000	
2	2	818,700	4.0469	
2	3	1,321,600	4.3594	
5	4	332,000	4.0000	
5	5	557,500	5.0312	
6	6	713,600	4.5000	
6	7	287,400	4.4219	
7	8	451,500	5.2188	
7	9	875,800	4.1562	
8	10	213,400	4.5312	
8	11	287,600	4.8125	
8	12	412,900	5.3125	
9	13	286,500	4.4062	
12	14	369,200	4.3594	
12	15	381,700	5.4375	
13	16	968,100	4.2969	
13	17	303,200	4.4062	
13	18	346,200	4.5625	
14	19	592,100	4.3281	
14	20	684,200	4.3750	
15	21	573,500	4.500	
15	22	362,500	4.7656	
17	23	582,800	3.9062	
17	24	136,700	4.9375	
18	25	376,800	4.0000	

* Subract from counter reading 200 cycles and enter in "Cycles to Failure" column.

Table 8.1-7 Cycles-to-Failure Data of Group No. 130 Using Wire Fatigue Machine No. 1 for 35 Specimens of .040 in. Diameter AISI 4130 Steel Wire. Fixed Alternating Stress Level of 70,000 psi. Bend Angle 20°. Coast-Down Cycles 200 .*

Operator: Chet Nolf

Date of Test	Spec. No.	Cycles-to-Failure	Break Length from Scribed End inches	Remarks
July 18	26	627,100	4.4688	
19	27	299,600	4.6875	
19	28	369,300	4.0938	
20	29	215,900	4.1094	
20	30	278,300	3.9375	
20	31	568,500	4.8125	
21	32	348,700	4.1250	
21	33	608,300	4.6719	
22	34	321,600	3.9844	
24	35	182,400	4.6875	

* Subract from counter reading 200 cycles and enter in "Cycles to Failure" column.

Table 8.1-8 Cycles-to-Failure Data of Group No. 131 Using Wire Fatigue Machine No. 1 for 35 Specimens of 0.40 in. Diameter AISI 4130 Steel Wire. Fixed Alternating Stress Level of 72,500 psi. Bend Angle 20.5° Coast-Down Cycles 200 .*

Operator: Chet Nolf

Date of Test	Spec. No.	Cycles-to-Failure	Break Length from Scribed End inches	Remarks
June 72				
22	1	384,100	4.8906	
23	2	141,800	5.1094	
23	3	392,100	4.4375	
23	4	220,500	4.2969	
24	5	186,600	5.0000	
24	6	100,300	5.1875	
24	7	181,000	4.5312	
26	8	476,400	4.5000	
26	9	150,600	4.7812	
27	10	151,700	4.7812	
27	11	433,700	5.2412	
28	12	469,100	4.5469	
28	13	143,200	4.1093	
29	14	289,800	4.4062	
29	15	201,900	5.0000	
29	16	272,600	4.8438	
29	17	113,800	4.7969	
30	18	693,000	4.9062	
July 72				
1	19	433,400	4.5000	
3	20	657,200	4.0156	
3	21	158,200	5.2188	
3	22	164,000	5.0938	
5	23	342,100	4.4375	
5	24	318,300	4.5938	

* Subract from counter reading 200 cycles and enter in "Cycles to Failure" column.

Table 8.1-8 Cycles-to-Failure Data of Group No. 131 Using Wire Fatigue Machine No. 1 for 35 Specimens of 0.40 in. Diameter AISI 4130 Steel Wire. Fixed Alternating Stress Level of 72,500 psi. Bend Angle 20.5° Coast-Down Cycles 200 .*

Operator: Chet Nolf

Date of Test	Spec. No.	Cycles-to-Failure	Break Length from Scribed End inches	Remarks
12	25	451,600	5.1562	
12	26	108,200	4.5312	
13	27	301,800	4.2188	
14	28	229,500	4.7188	
14	29	99,500	4.8438	
14	30	200,900	5.0000	
15	31	365,100	4.2188	
17	32	163,600	4.9062	
17	33	167,300	4.7812	
17	34	226,600	4.5000	
17	35	301,600	4.2188	

* Subract from counter reading 200 cycles and enter in "Cycles to Failure" column.

Table 8.1-9 Cycles-to-Failure Data of Group No. 132 Using Wire Fatigue Machine No. 1 for 35 Specimens of .040 in. Diameter AISI 4130 Steel Wire. Fixed Alternating Stress Level of 74,700 psi. Bend Angle 21.0° . Coast-Down Cycles 200 .*

Oper-ator	Date of Test	Spec. No.	Cycles-to-Failure	Break Length from Scribed End inches	Remarks
C.N.	July 24	1	207,100	4.6250	
	25	2	146,800	4.5312	
	25	3	104,700	4.2500	
	25	4	190,500	4.9219	
	25	5	224,800	4.7344	
	26	6	178,700	5.2656	
	26	7	137,800	5.0312	
	26	8	125,700	4.8906	
	27	9	237,700	5.0312	
	27	10	108,400	5.0000	
	27	11	191,700	4.5000	
	27	12	115,900	4.9219	
	28	13	127,400	5.1719	
	28	14	214,000	3.8750	
	28	15	73,100	4.6250	
	30	16	102,200	4.4062	
	31	17	101,400	4.9062	
	31	18	140,900	5.3750	
	31	19	173,700	4.7500	
	31	20	100,400	4.7656	
	31	21	369,800	4.5312	
	Aug. 1	22	100,500	4.6875	
	1	23	214,400	4.8281	
	1	24	119,800	4.9375	
	1	25	179,900	4.2969	

* Subract from counter reading 200 cycles and enter in "Cycles to Failure" column.

Table 8.1-9 Cycles-to-Failure Data of Group No. 132 Using Wire Fatigue Machine No. 1 for 35 Specimens of .040 in. Diameter AISI 4130 Steel Wire. Fixed Alternating Stress Level of 74,700 psi. Bend Angle 21.0° . Coast-Down Cycles 200 .*

Operator	Date of Test	Spec. No.	Cycles-to-Failure	Break Length from Scribed End inches	Remarks
C.N.	Aug. 2	26	197,400	4.8906	
	2	27	115,900	4.6875	
	3	28	140,600	4.5156	
	8	29	177,500	4.9062	
	8	30	121,700	4.7500	
	8	31	104,300	4.9375	
	8	32	93,300	4.4375	
	9	33	117,800	4.9531	
	9	34	138,400	4.7812	
	9	35	215,200	5.0312	

* Subract from counter reading 200 cycles and enter in "Cycles to Failure" column.

Table 8.1-10 Cycles-to-Failure Data of Group No. 133 Using Wire Fatigue Machine No. 1 for 35 Specimens of .040 in. Diameter AISI 4130 Steel Wire. Fixed Alternating Stress Level of 77,800 psi. Bend Angle 21.5° Coast-Down Cycles 200 .*

Operator	Date of Test	Spec. No.	Cycles-to-Failure	Break Length from Scribed End inches	Remarks
C.N.	Oct.72 1	1	56,900	5.0938	
	1	2	105,400	5.1250	
	1	3	125,100	4.5312	
	2	3	93,800	4.8281	
	2	5	247,100	4.6719	
	3	6	76,700	4.5312	
	3	7	71,800	4.5938	
	4	8	133,400	4.4375	
	4	9	137,500	4.5000	
	5	10	84,900	5.2188	
	5	11	111,300	4.5625	
	5	12	257,200	4.6719	
	6	13	137,100	5.0312	
	7	14	78,400	4.9375	
	7	15	120,200	4.4219	
	9	16	289,000	4.0469	
	9	17	106,300	4.9219	
	9	18	194.200	5.2812	
	10	19	96,200	4.9688	
	10	20	102,100	4.9375	
	11	21	196,900	5.2500	
	12	22	185,500	4.9062	
	12	23	197,200	5.1875	
	13	24	135,400	4.7812	
	13	25	112,700	5.1562	

* Subract from counter reading 200 cycles and enter in "Cycles to Failure" column.

Table 8.1-10 Cycles-to-Failure Data of Group No. 133 Using Wire Fatigue Machine No. 1 for 35 Specimens of .040 in. Diameter AISI 4130 Steel Wire. Fixed Alternating Stress Level of 77,800 psi. Bend Angle 21.5° . Coast-Down Cycles 200 .*

Oper-ator	Date of Test	Spec. No.	Cycles-to-Failure	Break Length from Scribed End inches	Remarks
C.N.	13	26	211,200	4.8438	
	16	27	195,000	4.4531	
	16	28	148,400	4.5136	
	16	29	114,600	4.7969	
	17	30	143,400	5.2031	
	17	31	107,300	4.0625	
	17	32	141,500	4.6250	
	18	33	49,500	4.7812	
	18	34	300,300	5.0000	
	18	35	74,200	5.2500	

* Subract from counter reading 200 cycles and enter in "Cycles to Failure" column.

Table 8.1-11 Static Ultimate Strength Test Data of Group No. 134 Using the Riehle Machine 35 Specimens of AISI 4130 Steel.

Date of Test: April 22, 1972

Specimen Number	Original Diameter in.	Original Cross Section Area in.^{2}	Yield Load lbs	Yield Stress psi	Ultimate Load lbs	Ultimate Stress psi	Breaking Load lbs	Breaking Diameter in.	Breaking Area in.	Breaking Stress psi
1	.0401	.001262			109	86,370	99	.0401	.001262	78,446
2	.0401	.001262			108	85,578	97	.0401	.001262	76,862
3	.0401	.001262			110	87,163	96	.0401	.001262	76,069
4	.0401	.001262			110	87,163	98	.0401	.001262	77,654
5	.0401	.001262			109	86,370	93	.0401	.001262	73,692
6	.0401	.001262			107	84,786	96	.0401	.001262	76,069
7	.0401	.001262			109	86,370	96	.0401	.001262	76,069
8	.0401	.001262			111	87,955	99	.0401	.001262	78,446
9	.0399	.001249			110	88,070	98	.0399	.001249	78,462
10	.0400	.001256			110	87,579	99	.0400	.001256	78,821
11	.0401	.001262			111	87,955	98	.0401	.001262	77,654
12	.0401	.001262			109	86,370	99	.0401	.001262	78,446
13	.0400	.001256			110	87,579	94	.0400	.001256	74,840
14	.0400	.001256			108	85,987	94	.0400	.001256	74,840
15	.0400	.001256			111	88,375	99	.0400	.001256	78,821
16	.0401	.001262			111	87,955	101	.0401	.001262	80,031
17	.0402	.001268			112	88,748	98	.0402	.001268	77,287
18	.0401	.001262			112	88,748	100	.0401	.001262	79,239
19	.0401	.001262			109	86,370	94	.0401	.001262	74,484
20	.0401	.001262			113	89,540	101	.0401	.001262	80,031
21	.0401	.001262			107	84,786	97	.0401	.001262	76,862

Table 8.1-11 Static Ultimate Strength Test Data of Group No. 134 Using the Riehle Machine
35 Specimens of AISI 4130 Steel.

Date of Test: April 22, 1972

Specimen Number	Original Diameter in.	Original Cross Section Area in.^{2}	Yield Load lbs	Yield Stress psi	Ultimate Load lbs	Ultimate Stress psi	Breaking Load lbs	Breaking Diameter in.	Breaking Area in.	Breaking Stress psi
22	.0401	.001262			108	85,578	95	.0401	.001262	75,277
23	.0401	.001262			113	89,540	99	.0401	.001262	78,446
24	.0401	.001262			111	87,955	99	.0401	.001262	78,446
25	.0401	.001262			112	88,748	102	.0401	.001262	80,824
26	.0403	.001274			111	87,127	100	.0403	.001274	78,492
27	.0400	.001256			108	85,987	98	.0400	.001256	78,025
28	.0401	.001262			111	87,955	100	.0401	.001262	79,239
29	.0401	.001262			109	86,370	96	.0401	.001262	76,069
30	.0401	.001262			112	88,748	102	.0401	.001262	80,824
31	.0401	.001262			112	88,748	98	.0401	.001262	77,654
32	.0402	.001268			110	86,750	99	.0402	.001268	78,075
33	.0401	.001262			110	87,163	97	.0401	.001262	76,862
34	.0401	.001262			109	86,370	101	.0401	.001262	80,031
35	.0401	.001262			113	89,540	96	.0401	.001262	75,069

Table 8.1-12 Test Data for Hardness and Ultimate Strength Elongation of Group No. 134. 35 Specimens of AISI 4130 Steel. D = .040 in. ; L = 10 in. Drawing No. ; Date of Test April 22, 1972

Specimen Number	CHARACTERISTIC			
	Rockwell Hardness Scale	Brinell Hardness BHN	ΔL on 8 in. Gage Length	Elongation %
1			.9219	11.523
2			.9375	11.718
3			.8750	10.937
4			.8437	10.546
5			.7187	8.984
6			.9375	11.718
7			.8594	10.742
8			1.0625	13.281
9			.8125	10.156
10			.9531	11.914
11			.9375	11.718
12			1.2187	15.234
13			1.0938	13.671
14			.8437	10.546
15			.9687	12.109
16			.9062	11.328
17			.9375	11.718
18			.9531	11.914
19			.8281	10.351
20			.9687	12.109
21			.8125	10.156
22			.9062	11.328
23			1.0625	13.381
24			1.1719	14.648
25			1.1875	14.843

Table 8.1-12 Test Data for Hardness and Ultimate Strength Elongation of Group No. 134. 35 Specimens of AISI 4130 Steel. D = .040 in. ; L = 10 in. Drawing No. ; Date of Test April 22, 1972

Specimen Number	CHARACTERISTIC			
	Rockwell Hardness Scale	Brinell Hardness BHN	ΔL on 8 in. Gage Length	Elongation %
26			.9687	12.109
27			.8750	10.937
28			1.0312	12.890
29			1.0312	12.890
30			.8437	10.546
31			1.0000	12.500
32			.9531	11.914
33			1.0312	10.890
34			.8906	11.132
35			.8906	11.132

Table 8.1-13 Cycles-to-Failure Data of Group No. 136 Using Wire Fatigue Machine No. 2 for 35 Specimens of .040 in. Diameter AISI 1038 Steel Wire. Fixed Alternating Stress Level of 64,500 psi. Bend Angle 17 . Coast-Down Cycles 200 .*

Operator: Chet Nolf

Date of Test	Spec. No.	Cycles-to-Failure	Break Length from Scribed End inches	Remarks
May 10	1	515,200	4.7812	
10	2	327,800	4.9219	
11	3	515,600	4.7188	
11	4	826,000	4.6406	
12	5	391,500	5.0000	
12	6	1,316,500	4.5000	
15	7	228,900	4.9062	
15	8	400,000	4.8438	
15	99	843,500	4.5625	
16	10	196,100	4.6875	
16	11	340,000	4.8125	
18	12	677,600	4.6094	
19	13	454,800	4.8438	
22	14	413,400	4.2500	
22	15	372,000	4.7969	
23	16	732,600	4.5938	
24	17	1,651,000	4.5000	
25	18	995,300	4.4219	
26	19	666,200	4.6719	
30	20	637,300	4.5000	
30	21	1,166,600	4.9688	
31	22	667,300	4.4688	
June 1	23	263,800	4.0000	
2	24	1,438,500	4.8906	
3	25	245,700	5.0000	

* Subract from counter reading 200 cycles and enter in "Cycles to Failure" column.

Table 8.1-13 Cycles-to-Failure Data of Group No. 136 Using Wire Fatigue Machine No. 2 for 35 Specimens of .040 in. Diameter AISI 1038 Steel Wire. Fixed Alternating Stress Level of 64,500 psi. Bend Angle 17. Coast-Down Cycles 200.*

Operator: Chet Nolf

Date of Test	Spec. No.	Cycles-to-Failure	Break Length from Scribed End inches	Remarks
6	26	280,700	4.7188	
6	27	536,300	4.7812	
6	28	651,600	4.3594	
7	29	731,800	4.7031	
8	30	512,700	4.7656	
8	31	673,500	4.1250	
9	32	454,400	4.5312	
9	33	434,700	4.9062	
12	34	585,000	5.2188	
13	35	151,200	4.9687	

* Subract from counter reading 200 cycles and enter in "Cycles to Failure" column.

Table 8.1-14 Cycles-to-Failure Data of Group No. 137 Using Wire Fatigue Machine No. 2 for 35 Specimens of 0.40 in. Diameter AISI 1038 Steel Wire. Fixed Alternating Stress Level of 67,200 psi. Bend Angle 17.5° Coast-Down Cycles 200 .*

Operator: Chet Nolf

Date of Test	Spec. No.	Cycles-to-Failure	Break Length from Scribed End inches	Remarks
June 72 27	1	782,500	4.9531	
27	2	776,100	5.1406	
27	3	237,900	5.1250	
27	4	209,800	5.0000	
27	5	635,800	5.3125	
28	6	243,100	4.6875	
28	7	799,500	5.0468	
29	8	267,000	4.1250	
30	9	483,700	4.8125	
30	10	299,800	5.0468	
30	11	243,100	4.8593	
July 72 1	12	213,700	4.8750	
3	13	224,600	4.3750	
3	14	267,000	4.9375	
5	15	305,500	5.4219	
5	16	426,800	4.7500	
6	17	614,700	4.0000	
7	18	381,300	4.7031	
7	19	486,700	4.8125	
8	20	497,500	4.1250	
9	21	164,300	4.9531	
10	22	329,400	5.1562	
10	23	269,200	4.7969	
11	24	394,600	5.1094	
11	25	439,000	4.9375	

* Subract from counter reading 200 cycles and enter in "Cycles to Failure" column.

Table 8.1-14 Cycles-to-Failure Data of Group No. 137 Using Wire Fatigue Machine No. 2 for 35 Specimens of .040 in. Diameter AISI 1038 Steel Wire. Fixed Alternating Stress Level of 67,200 psi. Bend Angle 17.5° Coast-Down Cycles 200 .*

Operator: Chet Nolf

Date of Test	Spec. No.	Cycles-to-Failure	Break Length from Scribed End inches	Remarks
12	26	201,600	5.1562	
12	27	97,000	4.7500	
12	28	143,300	5.0312	
12.	29	178,100	4.9531	
13	30	390,000	4.7188	
13	31	495,000	4.8215	
13	32	215,600	4.8281	
14	33	394,700	4.8906	
14	34	235,100	5.0469	
14	35	190,700	4.5938	

* Subract from counter reading 200 cycles and enter in "Cycles to Failure" column.

Table 8.1-15 Cycles-to-Failure Data of Group No. 138 Using Wire Fatigue Machine No. 2 for 35 Specimens of .040 in. Diameter AISI 1038 Steel Wire. Fixed Alternating Stress Level of 69,200 psi. Bend Angle 18.0° Coast-Down Cycles 200 .*

Operator	Date of Test	Spec. No.	Cycles-to-Failure	Break Length from Scribed End inches	Remarks
Chet	July 17	1	204,000	5.0000	
	17	2	291,400	5.0156	
	17	3	163,200	5.0469	
	17	4	105,400	5.0156	
	17	5	214,400	5.1094	
	18	6	90,800	5.1250	
	18	7	444,800	4.6250	
	18	8	207,200	4.8125	
	18	9	140,000	4.7656	
	19	10	150,300	4.8906	
	19	11	301,800	4.3906	
	19	12	388,000	4.6250	
	20	13	556,200	4.7188	
	20	14	207,400	5.0000	
	20	15	336,100	4.8438	
	21	16	834,500	4.6562	
	24	17	348,400	5.0469	
	24	18	129,700	4.7812	
	24	19	221,300	4.8594	
	25	20	208,700	4.7188	
	25	21	214,200	4.7344	
	25	22	163,500	4.7969	
	25	23	276,600	4.7031	
	26	24	177,200	4.1250	
	26	25	107,300	4.7500	

* Subract from counter reading 200 cycles and enter in "Cycles to Failure" column.

Table 8.1-15 Cycles-to-Failure Data of Group No. 138 Using Wire Fatigue Machine No. 2 for 35 Specimens of .040 in. Diameter AISI 1038 Steel Wire. Fixed Alternating Stress Level of 69,200 psi. Bend Angle 18.0° . Coast-Down Cycles 200 .*

Oper-ator	Date of Test	Spec. No.	Cycles-to-Failure	Break Length from Scribed End inches	Remarks
Chet	26	26	220,000	4.8594	
	27	27	168,900	4.9375	
	27	28	197,700	4.7812	
	27	29	164,400	5.0625	
	27	30	142,400	5.0781	
	28	31	123,400	5.0000	
	28	32	181,600	4.5938	
	28	33	258,500	4.5625	
	30	34	158,600	4.8906	
	31	35	167,800	5.0000	

* Subract from counter reading 200 cycles and enter in "Cycles to Failure" column.

Table 8.1-16 Cycles-to-Failure Data of Group No. 139 Using Wire Fatigue Machine No. 2 for 35 Specimens of .040 in. Diameter AISI 1038 Steel Wire. Fixed Alternating Stress Level of 72,300 psi. Bend Angle 18.5°. Coast-Down Cycles 200 .*

Oper-ator	Date of Test	Spec. No.	Cycles-to-Failure	Break Length from Scribed End inches	Remarks
C.N.	July 72 31	1	110,900	5.0000	
	31	2	213,400	5.3125	
	31	3	351,300	4.6562	
	Aug. 72 1	4	121,400	4.9062	
	1	55	83,700	5.2031	
	1	6	124,700	4.7656	
	1	7	118,400	5.0781	
	2	8	140,100	5.0000	
	2	9	95,400	4.8281	
	3	10	98,400	5.0469	
	3	11	105,500	5.2500	
	8	12	130,900	5.0000	
	8	13	108,100	4.8750	
	8	14	240,100	5.0000	
	9	15	104,800	4.9062	
	9	16	369,700	4.5000	
	9	17	250,900	4.8750	
	10	18	215,500	4.7969	
	10	19	200,600	4.8750	
	10	20	154,000	4.6094	
	11	21	137,000	4.3438	
	11	22	191,900	4.6250	
	14	23	338,500	4.3438	
	14	24	232,900	4.7344	
	16	25	281,000	4.7500	

* Subract from counter reading 200 cycles and enter in "Cycles to Failure" column.

Table 8.1-16 Cycles-to-Failure Data of Group No. 139 Using Wire Fatigue Machine No. 2 for 35 Specimens of .040 in. Diameter AISI 1038 Steel Wire. Fixed Alternating Stress Level of 72,300 psi. Bend Angle 18.5° . Coast-Down Cycles 200 .*

Operator	Date of Test	Spec. No.	Cycles-to-Failure	Break Length from Scribed End inches	Remarks
C.N.	16	26	97,400	5.2812	
	17	27	180,000	4.7500	
	17	28	199,600	4.7500	
	17	29	108,700	4.8750	
	18	30	250,700	4.6719	
	18	31	116,200	5.1250	
	21	32	172,300	4.6875	
	21	33	248,600	4.8125	
	22	34	165,700	4.6719	
	22	35	119,400	4.6719	

* Subract from counter reading 200 cycles and enter in "Cycles to Failure" column.

Table 8.1-17 Static Ultimate Strength Test Data of Group No. 141 Using the Riehle Machine
35 Specimens of AISI 1038 Steel.

Date of Test: April 8, 1972

Specimen Number	Original Diameter in.	Original Cross Section Area $in.^2$	Yield Load lbs	Yield Stress psi	Ultimate Load lbs	Ultimate Stress psi	Breaking Load lbs	Breaking Diameter in.	Breaking Area in.	Breaking Stress psi
1	.0398	.001243			99	79,646	81	.0398	.001243	65,164
2	.0398	.001243			92	74,014	70	.0398	.001243	63,555
3	.0397	.001237			92	74,373	78	.0397	.001237	63,055
4	.0398	.001243			97	78,037	81	.0398	.00143	63,055
5	.0397	.001237			93	75,181	81	.0397	.001237	65,481
6	.0397	.001237			92	74,373	74	.0397	.001237	59,822
7	.0397	.001237			99	80,032	81	.0397	.001237	65,481
8	.0397	.001237			98	79,223	82	.0397	.00137	66,289
9	.0397	.001237			94	75,990	79	.0397	.001237	63,864
10	.0398	.001243			98	78,841	80	.0398	.001243	64,360
11	.0397	.001237			95	76,798	78	.0397	.001237	63,055
12	.0397	.001237			96	77,607	78	.0397	.001237	63,055
13	.0397	.001237			96	77,607	79	.0397	.001237	63,864
14	.0398	.001243			94	75,623	80	.0398	.011243	64,360
15	.0397	.001237			94	75,990	77	.0397	.001237	62,247
16	.0396	.001231			96	77,985	80	.0296	.001230	64,987
17	.0397	.001237			92	74,373	77	.0397	.001237	62,247
18	.0396	.001231			95	79,200	79	.0396	.001231	64,175
19	.0397	.001237			98	79,223	81	.0397	.001237	65,481
20	.0397	.001237			96	77,607	81	.0397	.001237	65,481
21	.0395	.001224			97	79,248	80	.0395	.001224	65,359

Table 8.1-17 Static Ultimate Strength Test Data of Group No. 141 Using the Riehle Machine
35 Specimens of AISI 1038 Steel.

Date of Test: April 8, 1972

Specimen Number	Original Diameter in.	Original Cross Section Area in.^{2}	Yield Load lbs	Yield Stress psi	Ultimate Load lbs	Ultimate Stress psi	Breaking Load lbs	Breaking Diameter in.	Breaking Area in.	Breaking Stress psi
22	.0398	.001243			95	76,427	80	.0398	.001243	64,360
23	.0396	.001231			94	76,360	79	.0396	.001231	64,175
24	.0397	.001237			94	75,990	80	.0397	.001237	64,672
25	.0398	.001243			96	77,232	81	.0398	.001243	65,164
26	.0397	.001237			100	80,804	77	.0397	.001237	62,247
27	.0397	.001237			95	76,798	78	.0397	.001237	63,363
28	.0396	.001231			96	77,985	81	.0396	.001231	65,800
29	.0396	.001231			99	80,422	80	.0396	.001231	64,987
30	.0397	.001237			95	76,798	79	.0397	.001237	63,864
31	.0397	.001237			99	80,032	82	.0397	.001237	66,289
32	.0397	.001237			97	78,415	76	.0398	.001237	61,438
33	.0396	.001231			96	77,985	75	.0396	.001231	60,926
34	.0397	.001237			94	75,990	76	.0397	.001237	61,438
35	.0398	.001243			98	78,841	81	.0398	.001237	65,164

Table 8.1-18 Test Data for Hardness and Ultimate Strength Elongation of Group No. 141. 35 Specimens of AISI 1038 Steel. D = .040 in. ; L = 10 in. Drawing No. ; Date of Test April 8, 1972

Specimen Number	CHARACTERISTIC			
	Rockwell Hardness Scale	Brinell Hardness BHN	ΔL on 8 in. Gage Length	Elongation %
1			1.8437	23.046
2			1.6562	20.703
3			1.5625	19.531
4			1.7500	21.875
5			1.8437	23.046
6.			1.3437	16.796
7			1.9375	24.218
8			1.8594	23.242
9			1.5000	18.750
10			1.7500	21.875
11			1.7187	21.484
12			1.5000	18.750
13			1.5000	18.750
14			1.5625	19.531
15			1.5937	19.921
16			1.6562	20.703
17			1.7969	22.460
18			1.7500	21.875
19			1.9687	24.609
20			1.8750	23.437
21			1.6250	20.312
22			1.7187	21.484
23			1.6094	20.117
24			1.5312	19.140
25			1.6250	20.312

Table 8.1-18 Test Data for Hardness and Ultimate Strength Elongation of Group No. 141. 35 Specimens of AISI 1038 Steel. D = .040 in. ; L = 10 in. Drawing No. ; Date of Test April 8, 1972

Specimen Number	CHARACTERISTIC			
	Rockwell Hardness Scale	Brinell Hardness BHN	ΔL on 2 in. Gage Length	Elongation %
26			1.6406	20.507
27			1.8125	22.656
28			1.5156	18.945
29			1.6406	20.507
30			1.6875	21.093
31			2.0156	25.195
32			1.5312	19.140
33			1.6562	20.703
34			1.5937	19.921
35			1.8906	23.632

Table 8.1-19 Cycles-to-Failure Data of Group No. 143 Using Wire Fatigue Machine No. 3 for 35 Specimens of .040 in. Diameter AISI 1018 Steel Wire. Fixed Alternating Stress Level of 57,200 psi. Bend Angle 15.5° Coast-Down Cycles 200 .*

Operator: Chet Nolf

Date of Test	Spec. No.	Cycles-to-Failure	Break Length from Scribed End inches	Remarks
May 10	1	242,100	4.3750	
10	2	419,100	4.8281	
11	3	668,200	4.0312	
11	4	1,294,700	4.6250	
12	5	419,400	4.9219	
12	6	668,500	4.6875	
15	7	357,500	4.6719	
15	8	368,900	4.4375	
15	9	478,400	5.0312	
16	10	381,400	4.7969	
17	11	1,265,700	4.1250	
18	12	1,664,000	4.6406	
19	13	682,600	4.0312	
22	14	908,500	4.3594	
26	15	502,900	4.7031	
26	16	299,400	5.0312	
30	17	588,300	4.5938	
31	18	942,300	4.5781	
June 1	19	853,100	4.6406	
2	20	756,600	5.1250	
5	21	1,214,200	4.2656	
5	22	293,300	4.6719	
7	23	348,300	4.5469	
7	24	423,400	4.9688	
8	25	1,141,700	4.2344	

* Subract from counter reading 200 cycles and enter in "Cycles to Failure" column.

Table 8.1-19 Cycles-to-Failure Data of Group No. 143 Using Wire Fatigue Machine No. 3 for 35 Specimens of .040 in. Diameter AISI 1018 Steel Wire. Fixed Alternating Stress Level of 57,200 psi. Bend Angle 15.5° Coast-Down Cycles 200 .*

Operator: Chet Nolf

Date of Test	Spec. No.	Cycles-to-Failure	Break Length from Scribed End inches	Remarks
July 21	26	1,877,400	4.5000	
24	27	1,124,900	4.8125	
24	28	779,000	4.8281	
25	29	361,000	4.9219	
25	30	1,046,900	4.5000	
26	31	134,000	5.1250	
26	32	479,300	4.5000	
26	33	404,700	4.4375	
27	34	187,500	5.0312	
27	35	290,700	5.0000	

* Subract from counter reading 200 cycles and enter in "Cycles to Failure" column.

Table 8.1-20 Cycles-to-Failure Data of Group No. 144 Using Wire Fatigue Machine No. 3 for 35 Specimens of .040 in. Diameter AISI 1018 Steel Wire. Fixed Alternating Stress Level of 60,000 psi. Bend Angle 16.0° Coast-Down Cycles 200 .*

Operator: Chet Nolf

Date of Test	Spec. No.	Cycles-to-Failure	Break Length from Scribed End inches	Remarks
July 72 1	1	436,700	4.8125	
1	22	405,400	4.1406	
3	3	326,300	4.9219	
4	4	726,400	4.6250	
5	5	538,700	4.7344	
6	6	922,100	4.0000	
6	7	569,400	4.8281	
6	8	784,100	4.4688	
7	9	630,400	4.7500	
8	10	256,400	4.7969	
10	11	1,160,700	4.5000	
10	12	419,300	4.5625	
11	13	387,500	4.9219	
11	14	283,000	4.7969	
11	15	1,072,000	3.9375	
12	16	417,600	4.5625	
12	17	368,100	4.6875	
12	18	529,700	4.6250	
12	19	436,900	5.0000	
13	20	646,000	4.3750	
13	21	478,600	4.7500	
13	22	378,000	4.6875	
13	23	493,600	4.5469	
14	24	501,800	4.7344	
14	25	268,200	4.7500	

* Subract from counter reading 200 cycles and enter in "Cycles to Failure" column.

Table 8.1-20 Cycles-to-Failure Data of Group No. 144 Using Wire Fatigue Machine No. 3 for 35 Specimens of .040 in. Diameter AISI 1018 Steel Wire. Fixed Alternating Stress Level of 60,000 psi. Bend Angle 16.0° Coast-Down Cycles 200 .*

Operator: Chet Nolf

Date of Test	Spec. No.	Cycles-to-Failure	Break Length from Scribed End inches	Remarks
14	26	1,161,500	4.7656	
17	27	907,900	4.7188	
18	28	392,900	5.0312	
18	29	404,500	4.5938	
18	30	601,500	4.9062	
19	31	476,200	4.8125	
19	32	490,700	4.0000	
20	33	447,200	4.7188	
20	34	328,600	4.6875	
20	35	966,300	4.7031	

* Subract from counter reading 200 cycles and enter in "Cycles to Failure" column.

Table 8.1-21 Cycles-to-Failure Data of Group No. 145 Using Wire Fatigue Machine No. 3 for 35 Specimens of .040 in. Diameter AISI 1018 Steel Wire. Fixed Alternating Stress Level of 62,800 psi. Bend Angle 16.5° . Coast-Down Cycles 200 .*

Operator	Date of Test	Spec. No.	Cycles-to-Failure	Break Length from Scribed End inches	Remarks
C.N.	July 72 28	1	535,600	4.5838	
	30	2	415,100	4.8125	
	31	3	228,500	4.7969	
	31	4	272,600	4.6250	
	31	5	169,300	4.8750	
	31	6	516,300	4.6875	
	Aug. 72 1	7	159,100	5.0000	
	1	8	141,000	5.2500	
	1	9	176,500	4.8750	
	1	10	251,500	4.6562	
	2	11	417,700	4.7188	
	2	12	159,900	4.5000	
	3	13	487,300	4.8750	
	3	14	187,200	4.8906	
	8	15	295,100	5.0469	
	8	16	162,000	4.9062	
	9	17	344,100	4.6250	
	9	18	398,400	4.9062	
	9	19	459,000	4.7188	
	10	20	308,300	4.7969	
	11	21	258,900	4.5000	
	11	22	259,900	4.6562	
	14	23	484,900	4.3750	
	14	24	519,800	4.7188	
	16	25	329,500	4.4062	

* Subract from counter reading 200 cycles and enter in "Cycles to Failure" column.

Table 8.1-21 Cycles-to-Failure Data of Group No. 145 Using Wire Fatigue Machine No. 3 for Specimens of .040 in. Diameter AISI 1018 Steel Wire. Fixed Alternating Stress Level of 62,800 psi. Bend Angle 16.5°. Coast-Down Cycles 200 .*

Operator	Date of Test	Spec. No.	Cycles-to-Failure	Break Length from Scribed End inches	Remarks
C.N.	16	26	201,000	4.7500	
	17	27	720,900	4.8438	
	18	28	234,700	4.8281	
	21	29	433,100	4.8750	
	21	30	279,300	4.8125	
	22	31	171,700	4.5625	
	24	32	633,000	4.0000	
	28	33	193,000	4.8281	
	28	34	265,400	4.7969	
	Sept.72 5	35	185,300	4.7500	

* Subract from counter reading 200 cycles and enter in "Cycles to Failure" column.

Table 8.1-22 Static Ultimate Strength Test Data of Group No. 148 Using the Riehle Machine
35 Specimens of AISI 1018 Steel.

Date of Test: April 29. 1972

Specimen Number	Original Diameter in.	Original Cross Section Area $in.^2$	Yield Load lbs	Yield Stress psi	Ultimate Load lbs	Ultimate Stress psi	Breaking Load lbs	Breaking Diameter in.	Breaking Area $in.^2$	Breaking Stress psi
1	.0398	.001243			77	61,946	58	.0398	.001243	46,661
2	.0398	.001243			77	61,946	61	.0398	.001243	49,074
3	.0397	.001237			78	63,055	59	.0397	.001237	47,696
4	.0396	.001231			78	63,363	60	.0396	.001231	48,740
5	.0397	.001237			78	63,055	62	.0397	.001237	50,121
6	.0393	.001212			76	62,706	59	.0393	.001212	48,679
7	.0396	.001231			75	60,926	56	.0396	.001231	45,491
8	.0398	.001243			76	61,142	59	.0398	.001243	47,465
9	.0397	.001237			77	62,247	60	.0397	.001237	48,504
10	.0396	.001231			76	61,738	52	.0396	.001231	42,242
11	.0398	.001243			78	62,751	60	.0398	.001243	48,270
12	.0398	.001243			78	62,751	61	.0398	.001243	49,074
13	.0395	.001224			81	65,164	65	.0398	.001224	53,104
14	.0397	.001237			80	64,672	63	.0397	.001237	50,929
15	.0398	.001243			79	63,555	64	.0398	.001243	51,488
16	.0396	.001231			79	64,175	60	.0396	.001231	48,740
17	.0398	.001243			76	61,142	59	.0398	.001243	47,465
18	.0395	.001224			78	63,725	60	.0395	.001224	49,195
19	.0396	.001231			78	63,363	61	.0396	.001231	49,553
20	.0395	.001224			81	66,176	66	.0395	.001231	53,921
21	.0398	.001243			79	63,555	60	.0398	.001243	48,270

Table 8.1-22 Static Ultimate Strength Test Data of Group No. 148 Using the Riehle Machine
35 Specimens of AISI 1018 Steel.

Date of Test:

Specimen Number	Original Diameter in.	Original Cross Section Area in.^{2}	Yield Load lbs	Yield Stress psi	Ultimate Load lbs	Ultimate Stress psi	Breaking Load lbs	Breaking Diameter in.	Breaking Area in.	Breaking Stress psi
22	.0395	.001224			80	65,359	62	.0935	.001224	50,653
23	.0398	.001243			80	64,360	61	.0398	.001243	49,074
24	.0398	.001243			75	60,337	59	.0398	.001243	47,465
25	.0398	.001243			77	61,946	60	.0398	.001243	48,270
26	.0396	.001231			77	62,550	50	.0396	.001232	47,270
27	.0397	.001237			77	62,247	60	.0398	.001237	48,504
28	.0398	.001243			76	61,142	60	.0398	.001243	48,270
29	.0398	.001243			80	64,360	63	.0398	.001243	50,683
30	.0398	.001237			80	64,672	61	.0397	.001237	49,312
31	.0398	.001243			78	62,751	59	.0398	.001243	47,465
32	.0397	.001237			76	61,438	59	.0397	.001237	47,696
33	.0396	.001231			79	64,175	62	.0396	.001231	50,365
34	.0397	.001237			79	63,864	61	.0397	.001237	49,312
35	.0397	.001237			75	60,630	59	.0397	.001237	47,696

Table S.1-23 Test Data for Hardness and Ultimate Strength Elongation of Group No.143 . 35 Specimens of AISI 1018 Steel. D = .040 in. ; L = 10 in. Drawing No. . ; Date of Test April 29, 1972

Specimen Number	CHARACTERISTIC			
	Rockwell Hardness Scale	Brinell Hardness BHN	ΔL on 8 in. Gage Length	Elongation %
1			.9062	11.327
2			.8125	10.156
3			1.2343	15.428
4			.7500	9.375
5			1.0781	13.476
6			.9687	12.108
7			.8906	11.132
8			.9375	11.718
9			1.0156	12.695
10			.8437	10.546
11			.9843	12.303
12			1.1718	14.647
13			.8125	10.156
14			1.2656	15.820
15			1.3758	17.187
16			.7812	9.765
17			.9375	11.718
18			.8750	10.937
19			.8750	10.937
20			1.0315	12.893
21			1.2500	15.625
22			.9843	12.303
23			.8593	10.7412
24			1.1562	14.452
25			.9687	12.108

Table 8.1-23 Test Data for Hardness and Ultimate Strength Elongation of Group No. 148. 35 Specimens of AISI 1018 Steel. D = .040 in. ; L = 10 in. Drawing No. ; Date of Test April 29, 1972

Specimen Number	CHARACTERISTIC			
	Rockwell Hardness Scale	Brinell Hardness BHN	ΔL on 8 in. Gage Length	Elongation %
26			1.0156	12.695
27			1.1093	13.866
28			1.2812	16.015
29			1.1718	14.647
30			1.0312	12.890
31			1.0468	13.085
32			.9687	12.108
33			1.0000	12.500
34			1.1250	14.062
35			.9062	11.327

Table 8.1-24 KHN Hardness Data for Group No. 148-2 Using Tukon Micro-Hardness Tester For 10 Specimens of .040 in. Diameter. AISI 1018 Steel Wire.

Specimen Number	CHARACTERISTIC KNOOP HARDNESS, KHN		
1	165	169	166
2	166	159	166
3	162	173	166
4	166	174	169
5	165	162	164
6	177	169	175
7	175	188	182
8	171	174	177
9	174	175	169
10	169	170	168

Table 8.1-25 Cycles-to-Failure Data of Group No. 150 Using Wire Fatigue Machine No. 4 for 35 Specimens of .040 in. Diameter AISI 4340 Steel Wire. Fixed Alternating Stress Level of 73,500 psi. Bend Angle 20.5° . Coast-Down Cycles 100 .*

Operator: Chet Nolf

Date of Test	Spec. No.	Cycles-to-Failure	Break Length from Scribed End inches	Remarks
March72				
9	1	475,900	4.2188	
10	2	535,700	5.0000	
10	3	304,900	4.0938	
10	4	531,600	3.5200	
10	5	345,000	4.5000	
11	6	240,000	5.625	
12	7	410,900	4.6719	
13	8	334,100	5.4375	
13	9	335,100	4.7969	
14	10	260,500	4.0000	
14	11	709,800	5.1250	
14	12	463,800	4.3200	
14	13	342,700	5.0156	
15	14	312,300	4.5781	
15	15	571,400	4.5200	
15	16	126,300	4.6094	
16	17	375,400	4.3438	
16	18	258,900	4.7812	
16	19	214,900	4.2656	
16	20	234,300	4.375	
16	21	200,900	4.0312	
17	22	413,200	5.0120	
17	23	441,200	3.9531	
19	24	282,100	5.0000	

* Subract from counter reading 100 cycles and enter in "Cycles to Failure" column.

Table 8.1-25 Cycles-to-Failure Data of Group No. 150 Using Wire Fatigue Machine No. 4 for 35 Specimens of .040 in. Diameter AISI 4340 Steel Wire. Fixed Alternating Stress Level of 73,500 psi. Bend Angle 20.5° Coast-Down Cycles 100 .*

Operator: Chet Nolf

Date of Test	Spec. No.	Cycles-to-Failure	Break Length from Scribed End inches	Remarks
20	25	190,500	5.1250	
20	26	316,400	4.2812	
21	27	519,300	4.4531	
21	28	394,700	4.3594	
21	29	341,400	5.4375	
22	30	659,500	4.0000	
23	31	559,700	5.0000	
23	32	316,200	4.6875	
24	33	345,400	4.5938	
April				
4	34	635,200	4.2031	
4	35	809,900	4.5000	

* Subract from counter reading 100 cycles and enter in "Cycles to Failure" column.

Table 8.1-26 Cycles-to-Failure Data of Group No. 151 Using Wire Fatigue Machine No.4 for 35 Specimens of .040 in. Diameter AISI 4340 Steel Wire. Fixed Alternating Stress Level of 78,100 psi. Bend Angle 21.5° Coast-Down Cycles 100 .*

Operator: Chet Nolf

Date of Test	Spec. No.	Cycles-to-Failure	Break Length from Scribed End inches	Remarks
April 1	1	128,100	4.1875	
4	2	1[illegible]5,600	5.1875	
5	3	294,200	4.9219	
5	4	355,000	5.0312	
5	5	216,300	4.6719	
5	6	270,300	4.3281	
5	7	136,300	4.7344	
5	8	230,700	4.4375	
6	9	302,200	4.6250	
6	10	222,500	4.1562	
6	11	255,500	4.3438	
6	12	510,900	4.0000	
6	13	313,600	4.4606	
7	14	860,400	4.4375	
7	15	243,900	4.3438	
7	16	237,600	4.1875	
7	17	526,000	4.2656	
8	18	171,300	4.0469	
8	19	223,400	4.8750	
8	20	166,200	4.7812	
8	21	233,000	5.1250	
8	22	310,500	4.2188	
10	23	278,300	4.9688	
10	24	335,300	4.3750	
10	25	153,500	4.0000	

* Subract from counter reading 100 cycles and enter in "Cycles to Failure" column.

Table 8.1-26 Cycles-to-Failure Data of Group No. 151 Using Wire Fatigue Machine No. 4 for 35 Specimens of .040 in. Diameter AISI 4340 Steel Wire. Fixed Alternating Stress Level of 78,100 psi. Bend Angle 21.5° Coast-Down Cycles 100 .*

Operator: Chet Nolf

Date of Test	Spec. No.	Cycles-to-Failure	Break Length from Scribed End inches	Remarks
11	26	141,600	4.0000	
11	27	360,900	4.4062	
11	28	180,200	4.9531	
11.	29	193,400	4.8750	
12	30	161,800	4.8125	
12	31	753,700	4.8750	
12	32	617,400	4.0000	
12	33	224,500	4.0000	
13	34	235,900	4.2500	
13	35	216,300	4.6719	

* Subract from counter reading 100 cycles and enter in "Cycles to Failure" column.

Table 8.1-27 Cycles-to-Failure Data of Group No. 152 Using Wire Fatigue Machine No. 4 for 35 Specimens of .040 in. Diameter AISI 4340 Steel Wire. Fixed Alternating Stress Level of 80,100 psi. Bend Angle 22.0. Coast-Down Cycles 100 .*

Operator: Chet Nolf

Date of Test	Spec. No.	Cycles-to-Failure	Break Length from Scribed End inches	Remarks
April 13	1	185,800	4.2500	
13	2	229,000	4.5312	
13	3	254,000	4.0625	
13	4	205,500	4.0469	
13	5	163,400	4.5938	
14	6	114 000	4.4219	
14	7	382,000	4.4375	
14	8	507,700	4.4844	
14	9	114,700	4.1562	
14	10	161,900	4.2969	
17	11	176,800	4.3750	
17	12	536,200	4.2188	
17	13	679,500	4.8750	
17	14	253,900	4.1562	
18	15	148,800	4.7188	
18	16	401,100	4.9844	
18	17	87,500	4.5781	
18	18	283,300	4.6562	
19	19	245,500	4.2344	
19	20	215,000	4.3906	
19	21	306,600	4.3906	
19	22	227,400	4.7188	
19	23	188,000	4.3125	
19	24	241,000	3.8594	
21	25	80,000	4.5312	

* Subract from counter reading 100 cycles and enter in "Cycles to Failure" column.

Table 8.1-27 Cycles-to-Failure Data of Group No. 152 Using Wire Fatigue Machine No. 4 for 35 Specimens of .040 in. Diameter AISI 4340 Steel Wire. Fixed Alternating Stress Level of 80,100 psi. Bend Angle 22.0 . Coast-Down Cycles 100 .*

Operator: Chet Nolf

Date of Test	Spec. No.	Cycles-to-Failure	Break Length from Scribed End inches	Remarks
21	26	213,900	4.6094	
21	27	217,100	4.1462	
21	28	216,900	4.8438	
24	29	342,300	4.2188	
24	30	218,400	4.4062	
24	31	163,000	4.0156	
25	32	155,000	4.6250	
25	33	186,800	4.0938	
25	34	170,700	4.0000	
26	35	422,400	4.3125	

* Subract from counter reading 100 cycles and enter in "Cycles to Failure" column.

Table 8.1-28 Cycles-to-Failure Data of Group No. 153 Using Wire Fatigue Machine No. 4 for 35 Specimens of .040 in. Diameter AISI 4340 Steel Wire. Fixed Alternating Stress Level of 84,700 psi. Bend Angle 23.0°. Coast-Down Cycles 200 .*

Date of Test	Spec. No.	Cycles-to-Failure	Break Length from Scribed End inches	Remarks
April 72				
27	1	918,000	3.9688	
27	2	93,000	4.0000	
27	3	223,400	4.2812	
27	4	182,000	4.8595	
27	5	63,200	4.8438	
28	6	152,300	4.5624	
28	7	321,900	4.9219	
28	8	178,500	5.0000	
28	9	172,200	4.8281	
29	10	164,600	4.7656	
29	11	130,900	4.1250	
May 72				
1	12	117,500	4.750	
1	13	187,500	4.2188	
1	14	150,900	4,3438	
1	15	143,200	4.6875	
1	16	116,100	4.7500	
1	17	206,400	5.0000	
2	18	198,400	4.5000	
2	19	175,000	4.4688	
2	20	219,600	4.0312	
2	21	165,100	4.0469	
2	22	72,400	4.9219	
2	23	100,600	4.4219	

* Subract from counter reading 200 cycles and enter in "Cycles to Failure" column.

Table 8.1-28 Cycles-to-Failure Data of Group No. 153 Using Wire Fatigue Machine No. 4 for 35 Specimens of .040 in. Diameter AISI 4340 Steel Wire. Fixed Alternating Stress Level of 84,700 psi. Bend Angle 23.0°. Coast-Down Cycles 200 .*

Date of Test	Spec. No.	Cycles-to-Failure	Break Length from Scribed End inches	Remarks
3	24	150,200	4.0000	
3	25	222,800	5.1250	
3	26	114,700	4.7969	
3	27	115,900	4.2656	
3	28	66,800	4.8906	
4	29	98,600	5.1562	
4	30	162,500	4.4688	
4	31	259,300	4.6094	
4	32	125,000	4.5000	
4	33	120,500	4.9375	
4	34	192,900	4.2969	
5	35	250,300	4.5625	

* Subract from counter reading 200 cycles and enter in "Cycles to Failure" column.

Table 8.1-29 Cycles-to-Failure Data of Group No. 154 Using Wire Fatigue Machine No. 4 for 35 Specimens of .040 in. Diameter AISI 4340 Steel Wire. Fixed Alternating Stress Level of 90,000 psi. Bend Angle 24.0° Coast-Down Cycles 200 .*

Operator: Chet Nolf

Date of Test	Spec. No.	Cycles-to-Failure	Break Length from Scribed End inches	Remarks
May 5	1	105,200	4.0938	
5	2	116,500	5.0000	
8	3	102,900	5.2500	
8	4	92,800	4.3906	
9	5	99,400	4.0000	
9	6	127,600	4.2812	
9	7	108,500	5.0000	
9	8	100,900	4.4062	
9	9	72,000	4.2031	
9	10	173,800	4.2188	
10	11	113,800	4.8594	
10	12	178,500	4.9688	
10	13	99,000	5.1250	
10	14	94,500	4.6094	
10	15	91,100	4.0469	
11	16	93,700	5.0625	
11	17	98,900	4.5312	
11	18	70,100	5.0781	
11	19	155,600	4.8438	
11	20	196,200	4.4375	
12	21	276,900	4.8281	
12	22	154,200	5.4375	
12	23	90,800	4.8281	
12	24	92,000	4.4375	
15	25	163,700	4.5625	

* Subract from counter reading 200 cycles and enter in "Cycles to Failure" column.

Table 8.1-29 Cycles-to-Failure Data of Group No. 154 Using Wire Fatigue Machine No. 4 for 35 Specimens of .040 in. Diameter AISI 4340 Steel Wire. Fixed Alternating Stress Level of 90,000 psi. Bend Angle 24.0° Coast-Down Cycles 200 .*

Operator: Chet Noif

Date of Test	Spec. No.	Cycles-to-Failure	Break Length from Scribed End inches	Remarks
15	26	184,100	4.2812	
15	27	317,200	4.0000	
15	28	283,300	4.0938	
16	29	120,800	4.4375	
16	30	142,700	5.0469	
17	31	162,400	4.4375	
17	32	248,000	4.8906	
17	33	148,300	4.8594	
18	34	243,100	4.3438	
19	35	215,100	4.0000	

* Subract from counter reading 200 cycles and enter in "Cycles to Failure" column.

Table 8.1-30 Static Ultimate Strength Test Data of Group No. 155 Using the Riehle Machine
35 Specimens of AISI 4340 Steel.

Date of Test: April 30, 1972

Specimen Number	Original Diameter in.	Original Cross Section Area in.^{2}	Yield Load lb	Yield Stress psi	Ultimate Load lb	Ultimate Stress psi	Breaking Load lb	Breaking Diameter in.	Breaking Area in.	Breaking Stress psi
1	.0403	.001276			132	103,448	116	.0403	.001276	90,909
2	.0403	.001276			134	105,016	120	.0403	.001276	94,044
3	.0402	.001269			133	104,807	117	.0402	.001269	92,199
4	.0403	.001276			135	105,799	121	.0403	.001276	94,828
5	.0402	.001269			132	104,019	117	.0402	.001269	92,199
6	.0402	.001269			134	105,595	121	.0402	.001269	95,351
7	.0403	.001276			134	105,016	121	.0403	.001276	94,828
8	.0403	.001276			134	105,016	120	.0403	.001276	94,044
9	.0403	.001276			137	107,367	119	.0403	.001276	93,260
10	.0403	.001276			134	105,016	115	.0403	.001276	90,125
11	.0402	.001269			134	105,595	122	.0402	.001269	96,139
12	.0403	.001276			138	108,150	123	.0403	.001276	96,395
13	.0403	.001276			137	107,367	112	.0403	.001276	87,774
14	.0403	.001276			134	105,016	117	.0403	.001276	91,693
15	.0403	.001276			135	105,799	121	.0403	.001276	94,828
16	.0403	.001276			137	107,367	121	.0403	.001276	94,828
17	.0402	.001269			134	105,595	119	.0402	.001269	93,775
18	.0402	.001269			133	104,807	114	.0402	.001269	89,835
22	.0403	.001276			136	106,583	122	.0403	.001276	95,611
23	.0402	.001269			135	106,383	117	.0402	.001269	91,693
24	.0402	.001269			133	104,907	118	.0402	.001269	92,987

Table 8.1-30 Static Ultimate Strength Test Data of Group No. 155 Using the Reihle Machine 35 Specimens of AISI 4340 Steel.

Date of Test: April 30, 1972

Specimen Number	Original Diameter in.	Original Cross Section Area in.^{2}	Yield Load lb	Yield Stress psi	Ultimate Load lb	Ultimate Stress psi	Breaking Load lb	Breaking Diameter in.	Breaking Area in.	Breaking Stress psi
25	.0403	.001276			134	105,016	121	.0403	.001276	94,828
26	.0402	.001269			132	104,019	115	.0402	.001269	90,623
27	.0403	.001276			136	106,583	118	.0403	.001276	92,476
28	.0403	.001276			132	103,448	118	.0403	.001276	92,476
29	.04025	.0012724			134	105,313	120	.0403	.0012724	94,310
30	.0402	.001269			136	107,171	118	.0402	.001269	92,987
31	.0402	.001269			132	104,019	115	.0402	.001269	90,623
32	.0403	.001276			137	107,367	123	.0403	.001276	96,395
33	.0403	.001276			136	106,583	119	.0403	.001276	93,260
34	.0403	.001276			137	107,367	121	.0403	.001276	94,828
36	.0402	.001269			133	104,807	114	.0402	.001269	89,835
37	.04025	.0012724			133	104,527	121	.0403	.0012724	95,096
39	.0403	.001276			133	104,232	118	.0403	.001276	92,476
40	.0403	.001276			134	105,016	120	.0403	.001276	94,044

Table 8.1-31 Test Data for Hardness and Ultimate Strength Elongation of Group No. 155 . 35 Specimens of AISI 4340 Steel. D = .040 in. ; L = 10 in. Drawing No. ; Date of Test March 4, 1972

Specimen Number	CHARACTERISTIC			
	Rockwell Hardness Scale	Brinell Hardness BHN	ΔL on 8 in. Gage Length	Elongation %
37			.8573	10.741
25			.7500	9.375
24			.7812	9.765
2			.6406	8.007
12			.8281	10.351
32			.7343	9.178
18			.7656	9.570
16			.8593	10.741
22			.7500	9.375
4			.7968	9.960
8			.8593	10.741
5			.8750	10.071
23			.6250	7.812
39			.7656	9.570
34			.6875	8.593
40			.8437	10.546
33			.7500	9.375
7			.8437	10.546
6			.7968	9.960
14			.5937	7.421
15			.8281	10.351
1			.7181	8.976
9			.7343	9.178
3			.6718	8.397
30			.7500	9.375

Table 8.1-31 Test Data for Hardness and Ultimate Strength Elongation of Group No.155 . 35 Specimens of AISI 4340 Steel. D = .040 in. ; L = 10 in. Drawing No. ; Date of Test March 4, 1972

Specimen Number	CHARACTERISTIC			
	Rockwell Hardness Scale	Brinell Hardness BHN	ΔL on 2 in. Gage Length	Elongation %
29			.6093	7.616
36			.6718	8.397
27			.6718	8.397
31			.7968	9.960
11			.7187	8.983
10			.7968	9.982
17			.8281	10.351
26			.8593	10.741
13			.7343	9.178
28			.7968	9.960

Table 8.1-32 KHN Hardness Data for Group No. 155-2 Using Tukon Micro-Hardness Tester For 10 Specimens of .040 in. Diameter. AISI 4340Steel Wire.

Specimen Number	CHARACTERISTIC KNOOP HARDNESS, KHN		
1	201	186	207
2	184	201	198
3	212	196	201
4	204	196	201
5	200	197	204
6	205	201	204
7	197	198	208
8	203	201	200
9	201	200	207
10	202	202	205

8.2 WIEDEMANN FATIGUE MACHINE DATA

Table 8.2-1 Cycles-to-Failure Data of Group No. 89 Using the Wiedemann Machine. 36 Specimens of AISI 4130 Steel Rod of Test Section Diameter, d = .0937 in., Radius, r = .125 in. Upper Added Pan Load = 15.79 lbs. Alternating Stress = 75,000 psi.

Date of Test	Specimen Number	Cycles-to-Failure	Remarks*
May 1972 10	7	149,000	F
11	25	161,000	F
11	29	211,000	F
11	35	337,000	F
11	23	291,000	F
11	36	313,000	F
11	27	147,000	F
15	14	222,000	F
15	32	206,000	F
15	13	381,000	F
15	33	249,000	F
15	12	478,000	F
15	11	175,000	F
16	15	410,000	F
16	22	163,000	F
16	21	141,000	F
16	8	91,000	F
16	30	143,000	F
16	18	123,000	F
June 1972 6	16	170,000	F
6	10	345,000	F
6	1	680,000	F
6	28	253,000	F
6	26	122,000	F
6	24	157,000	F

* F - Failure

NF - No Failure

Table 8.2-1 Cycles-to-Failure Data of Group No. 89 Using the Upper Wiedemann Machine. 36 Specimens of AISI 4130 Steel Rod of Test Section Diameter, d = .0937 in., Radius, r = .125 in. Added Pan Load = 15.79 lbs. Alternating Stress = 75,000 psi.

Date of Test	Specimen Number	Cycles-to-Failure	Remarks*
6	31	196,000	F
6	34	138,000	F
6	9	297,000	F
7	5	183,000	F
7	17	235,000	F
7	3	122,000	F
7	2	194,000	F
7	20	225,000	F
7	19	221,000	F
7	6	205,000	F
7	4	138,000	F

*F - Failure

NF - No Failure

Table 8.2-2 Inspection Data for Critical and Major Characteristics of Group No. 89 . 36 Specimens of AISI 4130 Steel
$D = .375$ in. ; $L = 3.50$ in.
Drawing No. 200. ; Date of Inspection 4/1/72 .

Specimen Number	CHARACTERISTIC			
	Hardness	d= .0937 ± .0005 in.	r= .125 ± .002 in.	Surface Finish μ-in.
1		.0937	GO	4
2		.0937		
3		.0937		
4		.0937		
5		.0934		
6		.0935		
7		.0940		
8		.0939		
9		.0939		
10		.0937		
11		.0937		
12		.0938		
13		.0940		
14		.0937		
15		.0939		
16		.0941		
17		.0933		
18		.0936		
19		.0937		
20		.0933		
21		.0940		
22		.0939		
23		.0939		
24		.0936		
25		.0937		

Table 8.2-2 Inspection Data for Critical and Major Characteristics of Group No. 89 . 36 Specimens of AISI 4130 Steel
D = .375 in. ; L = 3.50 in.
Drawing No. 200 ; Date of Inspection 4/1/72 .

Specimen Number	CHARACTERISTIC			
	Hardness	d= .0937 ± .0005 in.	r= .125 ± .002 in.	Surface Finish μ-in.
26		.0937	GO	4
27		.0937		
28		.0937		
29		.0937		
30		.0937		
31		.0935		
32		.0939		
33		.0937		
34		.0935		
35		.0940		
36		.0937		

Table 8.2-3 Inspection Data for Critical and Major Characteristics of Group No. 90 . 37 Specimens of AISI 4130 Steel
D = .375 in. ; L = 3.5 in.
Drawing No. 200 ; Date of Inspection April 3, 1972

Specimen Number	CHARACTERISTIC			
	Hardness	d=.0937 ± .0005 in.	r= .125 ± .002 in.	Surface Finish μ-in.
1		.0940	.125	4
2		.0937		
3		.0938		
4		.0937		
5		.0940		
6		.0939		
7		.0937		
8		.0937		
9		.0939		
10		.0940		
11		.0937		
12		.0940		
13		.0940		
14		.0937		
15		.0939		
16		.0937		
17		.0937		
18		.0937		
19		.0937		
20		.0940		
21		.0937		
22		.0940		
23		.0939		
24		.0938		
25		.0939		

Table 8.2-3 Inspection Data for Critical and Major Characteristics of Group No. 90 . 37 Specimens of AISI 4130 Steel
D = .375 in. ; L = 3.5 in.
Drawing No. 200 ; Date of Inspection April 3, 1972

Specimen Number	CHARACTERISTIC Hardness	d= in.	r= in.	Surface Finish μ-in.
26		.0937	.125	4
27		.0940		
28		.0937		
29		.0937		
30		.0937		
31		.0939		
32		.0939		
33		.0940		
34		.0937		
35		.0937		
36		.0937		
37		.0937		

Table 8.2-4 Cycles-to-Failure Data of Group No. 90 Using the Wiedemann Machine. 37 Specimens of AISI 4130 Steel Rod of Test Section Diameter, d = .0937 in., Radius, r = .125 in. Upper Added Pan Load = 15.44 lbs. Alternating Stress = 85,000 psi.

Date of Test	Specimen Number	Cycles-to-Failure	Remarks*
May 1972 2	30	49,000	F
2	32	109,000	F
2	23	77,000	F
2	10	130,000	F
2	12	67,000	F
3	26	123,000	F
3	31	44,000	F
3	16	87,000	F
3	19	30,000	F
3	5	328,000	F
3	8	151,000	F
3	2	84,000	F
4	9	162,000	F
4	28	112,000	F
4	13	46,000	F
4	20	111,000	F
5	22	112,000	F
5	33	95,000	F
5	7	81,000	F
5	36	47,000	F
8	3	93,000	F
8	34	59,000	F
8	6	45,000	F
8	29	113,000	F
8	37	158,000	F

Table 8.2-4 Cycles-to-Failure Data of Group No. 90 Using the Wiedemann Machine. 37 Specimens of AISI 4130 Steel Rod of Test Section Diameter, d = .0937 in., Radius, r = .125 in. Upper Added Pan Load = 15.44 lbs. Alternating Stress = 85,000 psi.

Date of Test	Specimen Number	Cycles-to-Failure	Remarks *
8	27	187,000	F
8	17	91,000	F
9	25	80,000	F
9	15	133,000	F
9	1	116,000	F
9	11	77,000	F
10	18	106,000	F
10	4	165,000	F
10	35	88,000	F
10	24	123,000	F
10	14	130,000	F
10	21	107,000	F

Table 8.2-5 Inspection Data for Critical and Major Characteristics of Group No. 91 . 35 Specimens of AISI 4130 Steel
D = .375 in. ; L = 3.50 in.
Drawing No. 200 ; Date of Inspection April 4, 1972

Specimen Number	CHARACTERISTIC			
	Hardness	d= .0937 $\pm$ .0005 in.	r= .125 $\pm$ .002 in.	Surface Finish μ-in.
26		.0937	.125	4
27		.0937		
28		.0937		
29		.0937		
30		.0937		
31		.0937		
32		.0937		
33		.0937		
34		.0938		
35		.0937		
36		.0937		
37		.0937		

Table 8.2-5 Inspection Data for Critical and Major Characteristics of Group No. 91 . 36 Specimens of AISI 4130 Steel
D = .375 in. ; L = 3.50 in.
Drawing No. 200 ; Date of Inspection April 4, 1972

Specimen Number	CHARACTERISTIC			
	Hardness	d= .0937 ± .0005 in.	r= .125 ± .002 in.	Surface Finish μ-in.
1		.0937	.125	4
2		.0938		
3		.0937		
4		.0937		
5		.0939		
6		.0937		
7		.0937		
8		.0937		
9		.0937		
10		.0938		
11		.0937		
12		.0937		
13		.0937		
14		.0937		
15		.0937		
16		.0937		
17		.0937		
18		.0939		
19		.0937		
20		.0935		
21		.0935		
22		.0937		
23		.0937		
24		.0939		
25		.0937		

Table 8.2-6 Cycles-to-Failure Data of Group No. 91 Using the Wiedemann Machine. 37 Specimens of AISI 4130 Steel Rod of Test Section Diameter, d = .0937 in., Radius, r = .125 in. Upper Added Pan Load = 15.10 lbs. Alternating Stress = 95,000 psi.

Date of Test	Specimen Number	Cycles-to-Failure	Remarks*
April 1972			
12	25	21,000	F
12	16	34,000	F
12	14	13,000	F
13	35	12,000	F
13	20	16,000	F
13	4	8,000	F
13	1	39,000	F
13	23	31,000	F
14	32	32,000	F
14	3	12,000	F
14	17	34,000	F
17	31	18,000	F
17	37	23,000	F
17	6	18,000	F
17	15	21,000	F
17	35	34,000	F
18	5	14,000	F
18	7	13,000	F
18	34	16,000	F
19	8	25,000	F
19	19	17,000	F
20	18	20,000	F
20	26	27,000	F
24	13	17,000	F
24	24	33,000	F

Table 8.2-6 Cycles-to-Failure Data of Group No. 91 Using the Wiedemann Machine. 37 Specimens of AISI 4130 Steel Rod of Test Section Diameter, d = .0937 in., Radius, r = .125 in. Upper Added Pan Load = 15.10 lbs. Alternating Stress = 95,000 psi.

Date of Test	Specimen Number	Cycles-to-Failure	Remarks*
24	22	15,000	F
24	28	5,000	F
25	29	24,000	F
26	33	21,000	F
26	11	18,000	F
26	9	16,000	F
26	10	18,000	F
28	2	17,000	F
28	27	22,000	F
28	12	25,000	F
May 1972 1	30	32,000	F
1	21	22,000	F

Table 8.2-7 Inspection Data for Critical and Major Characteristics of Group No. 93 . 35 Specimens of AISI 4130 Steel
D = .375 in. ; L = 3.50 in.
Drawing No. 200 ; Date of Inspection March 30, 1972

Specimen Number	CHARACTERISTIC			
	Hardness	d= .0937 ± .0005 in.	r= .250 ±.002 in.	Surface Finish μ-in.
1		.0937	.250	4
2		.0936		
3		.0939		
4		.0940		
5		.0937		
6		.0937		
7		.0939		
8		.0936		
9		.0937		
10		.0939		
11		.0939		
12		.0937		
13		.0937		
14		.0937		
15		.0938		
16		.0937		
17		.0937		
18		.0937		
19		.0937		
20		.0937		
21		.0936		
22		.0937		
23		.0937		
24		.0940		
25		.0937		

Table 8.2-7 Inspection Data for Critical and Major Characteristics of Group No. 93 . 35 Specimens of AISI 4130 Steel
D = .375 in. ; L = 3.50 in.
Drawing No. 200 ; Date of Inspection March 30, 1972

Specimen Number	CHARACTERISTIC			
	Hardness	$d = .0937 \pm .0005$ in.	$r = .250 \pm .002$ in.	Surface Finish μ-in.
26		.0937	.250	4
27		.0940		
28		.0937		
29		.0939		
30		.0934		
31		.0936		
32		.0937		
33		.0940		
34		.0937		
35		.0937		

Table 8.2-8 Cycles-to-Failure Data of Group No. 93 Using the Wiedemann Machine. 35 Specimens of AISI 4130 Steel Rod of Test Section Diameter, d = .0937 in., Radius, r = .250 in. Added Pan Load = 15.96 lbs. Alternating Stress = 70,000 Upper psi.

Date of Test 1972	Specimen Number	Cycles-to-Failure	Remarks
4/3	29	37,000	F
4/3	21	52,000	F
4/3	16	53,000	F
4/3	24	67,000	F
4/3	19	60,000	F
4/3	26	94,000	F
4/4	12	81,000	F
4/4	13	133,000	F
4/4	32	122,000	F
4/4	4	147,000	F
4/4	10	149,000	F
4/4	28	163,000	F
4/4	33	38,000	F
4/4	8	24,000	F
4/5	20	36,000	F
4/5	25	34,000	F
4/6	30	64,000	F
4/6	14	193,000	F
4/6	34	50,000	F
4/6	27	123,000	F
4/6	23	97,000	F
4/6	6	106,000	F
4/7	15	61,000	F
4/7	22	116,000	F
4/7	9	45,000	F

*F = Failure

NF = No Failure

Table 8.2-8 Cycles-to-Failure Data of Group No. 93 Using the Wiedemann Machine. 35 Specimens of AISI 4130 Steel Rod of Test Section Diameter, d = .0937 in., Radius, r = .250 in. Added Pan Load = 15.96 lbs. Alternating Stress = 70,000 Upper psi.

Date of Test	Specimen Number	Cycles-to-Failure	Remarks *
4/7	31	16,000	F
4/7	18	60,000	F
4/11	5	35,000	F
4/11	17	17,000	F
4/11	7	28,000	F
4/11	11	66,000	F
4/11	3	57,000	F
4/11	1	63,000	F
4/11	2	87,000	F
4/11	35	142,000	F

Table 8.2-9 Inspection Data for Critical and Major Characteristics of Group No. 94 . 35 Specimens of AISI 4130 Steel
D = .375 in. ; L = 3.50 in.
Drawing No. 200 ; Date of Inspection March 29, 1972.

Specimen Number	CHARACTERISTIC Hardness	d= .0937 ± .0005 in.	r= .250 ± .002 in.	Surface Finish μ-in.
1		.0939	GO	4
2		.0937		
3		.0937		
4		.0937		
5		.0933		
6		.0938		
7		.0937		
8		.0937		
9		.0937		
10		.0938		
11		.0937		
12		.0938		
13		.0933		
14		.0937		
15		.0938		
16		.0937		
17		.0938		
18		.0937		
19		.0935		
20		.0937		
21		.0937		
22		.0940		
23		.0937		
24		.0938		
25		.0940		

Table 8.2-9 Inspection Data for Critical and Major Characteristics of Group No. 94 . 35 Specimens of AISI 4130 Steel
D = .375 in. ; L = .350 in.
Drawing No. 200 ; Date of Inspection March 29, 1972.

Specimen Number	CHARACTERISTIC			
	Hardness	d= .0937 $\pm$ .0005 in.	r= .250 $\pm$ .002 in.	Surface Finish μ-in.
26		.0937	GO	4
27		.0938		
28		.0937		
29		.0937		
30		.0938		
31		.0936		
32		.0937		
33		.0937		
34		.0937		
35		.0938		

Table 8.2-10 Cycles-to-Failure Data of Group No. 94 Using the Wiedemann Machine. 35 Specimens of AISI 4130 Steel Rod of Test Section Diameter, d = .0937 in., Radius, r = .250 in. Upper Added Pan Load = 15.62lbs. Alternating Stress = 80,000 psi.

Date of Test 1972	Specimen Number	Cycles-to-Failure	Remarks
3/29	9	26,000	F
3/29	18	18,000	F
3/29	5	16,000	F
3/29	17	28,000	F
3/30	13	19,000	F
3/30	26	12,000	F
3/30	27	19,000	F
3/30	29	23,000	F
3/30	15	29,000	F
3/30	4	27,000	F
3/30	22	31,000	F
3/30	20	16,000	F
3/30	31	22,000	F
3/30	16	59,000	F
3/30	35	31,000	F
3/31	19	29,000	F
3/31	10	40,000	F
3/31	14	32,000	F
3/31	21	36,000	F
3/31	30	41,000	F
3/31	33	32,000	F
3/31	28	31,000	F
3/31	7	19,000	F
3/31	32	19,000	F
3/31	2	34,000	F

* F = Failure

NF = No Failure

Table 8.2-10 Cycles-to-Failure Data of Group No. 94 Using the Wiedemann Machine. 35 Specimens of AISI 4130 Steel Rod of Test Section Diameter, d = .0937 in., Radius, r = .250 in. Added Pan Load = 15.62 lbs. Alternating Stress = 80,000 Upper psi.

Date of Test 1972	Specimen Number	Cycles-to-Failure	Remarks
3/31	24	29,000	F
4/3	1	16,000	F
4/3	23	30,000	F
4/3	12	22,000	F
4/3	25	41,000	F
4/3	8	26,000	F
4/3	3	26,000	F
4/3	34	21,000	F
4/3	11	16,000	F
4/3	6	40,000	F

* F = Failure

NF = No Failure

Table 8.2-11 Cycles-to-Failure Data of Group No. 95 Using the Wiedemann Machine. 34 Specimens of AISI 4130 Steel Rod of Test Section Diameter, d = .0937 in., Radius, r = .250 in. Upper Added Pan Load = 15.10 lbs. Alternating Stress = 95,000 psi.

Date of Test 1972	Specimen Number	Cycles-to-Failure	Remarks
3/10	18	8,000	F
3/10	15	7,000	F
3/10	10	5,000	F
3/10	21	9,000	F
3/13	12	13,000	F
3/13	11	3,000	F
3/13	17	2,000	F
3/14	14	9,000	F
3/14	20	5,000	F
3/14	13	2,000	F
3/14	4	3,000	F
3/15	22	7,000	F
3/16	7	9,000	F
3/16	23	6,000	F
3/17	34	11,000	F
3/17	3	5,000	F
3/17	33	6,000	F
3/17	31	4,000	F
3/17	25	11,000	F
3/24	4	2,000	F
3/24	32	5,000	F
3/24	26	11,000	F
3/24	27	3,000	F
3/29	29	6,000	F
3/29	2	4,000	F

* F - Failure
NF. = No Failure

Table 8.2-11 Cycles-to-Failure Data of Group No. 95 Using the Wiedemann Machine. 34 Specimens of AISI 4130 Steel Rod of Test Section Diameter, d = .0937 in., Radius, r = .250 in. Upper Added Pan Load = 15.10 lbs. Alternating Stress = 95,000 psi.

Date of Test	Specimen Number	Cycles-to-Failure	Remarks
3/29	30	3,000	F
3/29	24	4,000	F
3/29	1	10,000	F
3/29	9	2,000	F
3/29	6	2,000	F
3/29	8	4,000	F
3/29	28	3,000	F
3.29	5	4,000	F

* F - Failure

NF - No Failure

Table 8.2-12 Inspection Data for Critical and Major Characteristics of Group No. 95 . 34 Specimens of AISI 4130 Steel
D = .375 in. ; L = 3.00 in.
Drawing No. 200 ; Date of Inspection 3/8/72 .

Specimen Number	CHARACTERISTIC			
	Hardness	d= .0937 $\pm$ .0005 in.	r= .250" $\pm$ .002 in.	Surface Finish µ-in.
1		.0941	GO	4
2		.0937		
3		.0936		
4		.0937		
5		.0937		
6		.0934		
7		.0937		
8		.0933		
9		.0938		
10		.0939		
11		.0937		
12		.0937		
13		.0937		
14		.0940		
15		.0938		
16		.0937		
17		.0935		
18		.0937		
19		.0937		
20		.0935		
21		.0937		
22		.0936		
23		.0934		
24		.0937		
25		.0937		

Table 8.2-12 Inspection Data for Critical and Major Characteristics of Group No. 95 . 34 Specimens of AISI 4130 Steel
D = .375 in. ; L = 3.00 in.
Drawing No. 200 ; Date of Inspection 3/8/72.

Specimen Number	CHARACTERISTIC			
	Hardness	d= ,0937" $\pm$ .0005" in.	r= .250" $\pm$ .002" in.	Surface Finish μ-in.
26		.0935	GO	4
27		.0937		
28		.0933		
29		.0940		
30		.0937		
31		.0937		
32		.0937		
33		.0937		
34		.0939		

Table 8.2-13 Staircase Method Data of Group No. 162 Using the R. R. Moore Machine. 35 Specimens of AISI 1038 Steel Rod with Test Section Diameter, d = .2700 in., Radius r = .031 in. Cutoff at 3×10^6 cycles.

Date of Test	Spec. No.	Added Pan Load lbs	Alternating Stress	Cycles of Operation $\times 10^{-5}$	Remarks*
1972 3/7	37	8.36	19,000	3,108,000	N F
3/8	13	10.29	21,000	9,101,000	N F
3/9	11	12.22	23,000	3,429,000	N F
3/9	27	14.15	25,000	1,280,000	F
3/10	9	12.22	23,000	3,000,000	N F
3/16	14	14.15	25,000	1,438,000	F
3/17	5	12.22	23,000	3,442,000	N F
3/17	4	14.15	25,000	802,000	F
3/20	7	12.22	23,000	3,141,000	N F
3/21	6	14.15	25,000	1,347,000	F
3/21	25	12.22	23,000	3,560,000	N F
3/22	16	14.15	25,000	2,100,000	F
3/23	1	12.22	23,000	5,224,000	N F
3/24	34	14.15	25,000	1,464,000	F
3/24	12	12.22	23,000	2,564,000	F
3/29	29	10.29	21,000	3,020,000	N F
3/29	24	12.22	23,000	3,183,000	N F
3/29	15	14.15	25,000	1,285,000	F
3/30	26	12.22	23,000	3,097,000	N F
3/30	19	14.15	25,000	1,294,000	F
3/30	35	12.22	23,000	3,190,000	N F
3/30	30	14.15	25,000	781,000	F
3/31	18	12.22	23,000	3,043,000	N F
3/31	36	14.15	25,000	1,748.000	F
4/1	31	12.22	23,000	3,128,000	N F
4/3	33	14.15	25,000	865,000	F

* N F - No Failure
F - Failure

Table 8.2-13 Staircase Method Data of Group No. 162 Using the R. R. Moore Machine. 35 Specimens of AISI 1038 Steel Rod with Test Section Diameter, d = .2700 in., Radius r = .031 in. Cutoff at $3x10^6$ cycles.

Date of Test	Spec. No.	Added Pan Load lbs	Alternating Stress	Cycles of Operation $x 10^{-5}$	Remarks*
1972 4/3	21	12.22	23,000	3,820,000	N F
4/3	10	14.15	25,000	1,049,000	F
4/4	23	12.22	23,000	3,122,000	N F
4/4	22	14.15	25,000	1,585,000	F
4/4	20	12.22	23,000	3,273,000	N F
4/5	3	14.15	25,000	1,479,000	F
4/5	32	12.22	23,000	2,336,000	F
4/6	2	10.29	21,000	3,787,000	NF
4/6	38	12.22	23,000	3,113,000	N F

* N F - No Failure
F - Failure

Table 8.2-14 Inspection Data for Critical and Major Characteristics of Group No. 162 . 38 Specimens of AISI 1038 Steel
D = .375 in. ; L = 2.75 in.
Drawing No. 200 .

Date of Test: 3/7/72 Operator: J.D.S.

Specimen Number	CHARACTERISTIC			
	Hardness	d= .2700 ± .0010 in.	r= .031 in.	Surface Finish 4 μ-in.
1		.2700	GO	4
2		.2700		
3		.2706		
4		.2700		
5		.2700		
6		.2700		
7		.2700		
8		.2700		
9		.2703		
10		.2700		
11		.2705		
12		.2700		
13		.2700		
14		.2700		
15		.2700		
16		.2703		
17		.2700		
18		.2702		
19		.2698		
20		.2699		
21		.2703		
22		.2700		
23		.2700		
24		.2705		
25		.2700		

Table 8.2-14 Inspection Data for Critical and Major Characteristics
of Group No. 162 . 38 Specimens of AISI 1038 Steel
D = .375 in. ; L = 2.75 in.
Drawing No. 200 .

Date of Test: 3/7/72 Operator: J.D.S.

Specimen Number	CHARACTERISTIC			
	Hardness	d= .2700 ± .0010 in.	r= .031 in.	Surface Finish 4 μ-in.
26		.2705	GO	4
27		.2700		
28		.2705		
29		.2709		
30		.2700		
31		.2700		
32		.2705		
33		.2707		
34		.2700		
35		.2700		
36		.2700		
37		.2703		
38		.2700		

Table 8.2-15 Staircase Method Data of Group No. 163 Using the R. R. Moore Machine. 37 Specimens of AISI 1038 Steel Rod with Test Section Diameter, d = .2700 in., Radius r = .062 in. Cutoff at 3 x 10^6 cycles.

Date of Test	Spec. No.	Added Pan Load lbs	Alternating Stress	Cycles of Operation	Remarks*
April 72 7	32	14.15	25,000	11,223,000	N F
11	19	16.09	27,000	3,000,000	N F
11	33	18.02	29,000	702,000	F
12	26	16.09	27,000	12,248,000	N F
13	23	18.02	29,000	1,426,000	F
13	3	16.09	27,000	3,452,000	N F
14	30	18.02	29,000	1,481,000	F
14	5	16.09	27,000	3,000,000	N F
17	10	18.02	29,000	1,522,000	F
17	31	16.09	27,000	4,729,000	N F
18	11	18.02	29,000	1,194,000	F
18	2	16.09	27,000	639,000	F
19	1	14.15	25,000	3,138,000	N F
19	24	16.09	27,000	2,474,000	F
20	26	14.15	25,000	2,769,000	F
24	4	12.22	23,000	3,091,000	N F
24	8	14.15	25,000	2,269,000	F
25	25	12.22	23,000	9,397,000	N F
26	36	14.15	25,000	3,859,000	N F
26	27	16.09	27,000	3,465,000	N F
28	35	18.02	29,000	1,721,000	F
28	14	16.09	27,000	11,890,000	N F
May 72 1	37	18.02	29,000	1,881,000	F
1	12	16.09	27,000	1,386,000	F
2	34	14.15	25,000	3,045,000	N F
2	16	16.09	27,000	1,985,000	F

* N F - No Failure
F - Failure

Table 8.2-15 Staircase Method Data of Group No. 163 Using the R. R. Moore Machine. 37 Specimens of AISI 1038 Steel Rod with Test Section Diameter, d = .2700 in., Radius r = .062 in. Cutoff at 3×10^6 cycles.

Date of Test	Spec. No.	Added Pan Load lbs	Alternating Stress	Cycles of Operation	Remarks*
2	13	14.15	25,000	1,095,000	F
3	8	12.22	23,000	3,122,000	N F
3	22	14.15	25,000	3,270,000	N F
3	9	16.09	27,000	1,412,000	F
4	20	14.15	25,000	11,676,000	N F
5	15	16.09	27,000	3,101,000	N F
5	21	18.02	29,000	2,280,000	F
8	7	16.09	27,000	3,369,000	N F
8	29	18.02	29,000	983,000	F
8	17	16.09	27,000	2,359,000	F
9	6	14.15	25,000	3,623,000	N F

* N F - No Failure
F - Failure

Table 8.2-16. Inspection Data for Critical and Major Characteristics of Group No. 163 . 37 Specimens of AISI 1038 Steel
D = .375 in. ; L = 2.75 in.
Drawing No. 200 .

Date of Test: 3/31/72 Operator: J.D.S.

Specimen Number	CHARACTERISTIC			
	Hardness	d= .2700 ± .0005 in.	r= .062 ± .002 in.	Surface Finish 4 μ-in.
1		.2705	GO	4
2		.2705		
3		.2700		
4		.2700		
5		.2700		
6		.2700		
7		.2700		
8		.2700		
9		.2700		
10		.1700		
11		.2700		
12		.2700		
13		.2705		
14		.2700		
15		.2700		
16		.2703		
17		.2700		
18		.2703		
19		.2700		
20		.2700		
21		.2705		
22		.2700		
23		.2700		
24		.2700		
25		.2700		

Table 8.2-16. Inspection Data for Critical and Major Characteristics of Group No. 163. 37 Specimens of AISI 1038Steel
D = .375 in. ; L = 2.75 in.
Drawing No. 200 .

Date of Test: 3/31/72 Operator: J.D.S.

Specimen Number	CHARACTERISTIC			
	Hardness	d= .2700 ± .0005 in.	r= .062 ± .002 in.	Surface Finish 4 µ-in.
26		.2700	GO	4
27		.2700		
28		.2705		
29		.2700		
30		.2702		
31		.2700		
32		.2700		
33		.2700		
34		.2700		
35		.2700		
36		.2705		
37		.2700		

Table 8.2-17 Staircase Method Data of Group No. 164 Using the R. R. Moore Machine. 37 Specimens of AISI 1038 Steel Rod with Test Section Diameter, d = 0.2700 in., Radius r = 0.125 in. Cutoff at 3 x 10^6 cycles.

Operator:

Date of Test	Spec. No.	Added Pan Load lbs	Alternating Stress	Cycles of Operation	Remarks*
5/10/72	1	19.23	30,000	4,340,000	NF
5/11/72	22	21.16	32,000	949,000	F
5/11/72	37	19.23	30,000	12,873,000	NF
5/12/72	21	21.16	32,000	623,000	F
5/15/72	34	19.23	30,000	3,137,000	NF
5/15/72	13	21.16	32,000	3,773,000	NF
5/15/72	14	23.09	34,000	1,153,000	F
5/16/72	29	21.16	32,000	2,337,000	F
5/16/72	23	19.23	30,000	2,095,000	F
6/06/72	18	17.29	28,000	3,055,000	NF
6/06/72	9	19.23	30,000	313,000	F
6/06/72	8	17.29	28,000	3,122,000	NF
6/06/72	19	19.23	30,000	4,478,000	NF
6/07/72	36	21.16	32,000	3,097,000	NF
6/07/72	15	23.09	34,000	705,000	F
6/07/72	24	21.16	32,000	1,251,000	F
6/08/72	33	19.23	30,000	3,077,000	NF
6/08/72	11	21.16	32,000	1,922,000	F
6/09/72	25	19.23	30,000	3,546,000	NF
6/10/72	31	21.16	32,000	1,722,000	F
6/11/72	17	19.23	30,000	2,900,000	F
6/12/72	7	17.29	28,000	3,121,000	NF
6/12/72	30	19.23	30,000	3,139,000	NF
6/12/72	32	21.16	32,000	1,249,000	F
6/12/72	35	19.23	30,000	2,126,000	F
6/13/72	16	17.29	28,000	3,021,000	NF

* N F - No Failure
F - Failure

Table 8.2-17 Staircase Method Data of Group No. 164 Using the R. R. Moore Machine. 37 Specimens of AISI 1038 Steel Rod with Test Section Diameter, d = 0.2700 in., Radius r = 0.125 in. Cutoff at 3×10^6 cycles.

Date of Test	Spec. No.	Added Pan Load lbs	Alternating Stress	Cycles of Operation	Remarks*
6/13/72	4	19.23	30,000	2,430,000	F
6/13/72	27	17.29	28,000	8,084,000	NF
6/16/72	10	19.23	30,000	3,000,000	NF
6/16/72	3	21.16	37,000	946,000	F
6/19/72	26	19.23	30,000	2,740,000	F
6/20/72	5	17.29	28,000	3,057,000	NF
6/20/72	12	19.23	30,000	3,054,000	NF
6/20/72	2	21.16	32,000	577,000	F
6/21/72	20	19.23	30,000	2,883,000	F
6/22/72	6	17.29	28,000	13,523,000	NF
6/23/72	20	19.23	30,000	3,239,000	NF

* N F -. No Failure
F - Failure

Table 8.2-18 Inspection Data for Critical and Major Characteristics of Group No. 164 . 37 Specimens of AISI 1038 Steel
D = .375 in. ; L = 2.75 in.
Drawing No. 200 .

Date of Test: 3/7/72 Operator: J.D.S.

Specimen Number	CHARACTERISTIC			
	Hardness	d= .2700 ± .0090 in.	r= .1250 ± .002 in.	Surface Finish μ-in.
1		.2695	GO	
2		.2703		
3		.2700		
4		.2700		
5		.2705		
6		.2700		
7		.2700		
8		.2700		
9		.2705		
10		.2703		
11		.2705		
12		.2705		
13		.2700		
14		.2700		
15		.2700		
16		.2700		
17		.2700		
18		.2705		
19		.2702		
20		.2700		
21		.2704		
22		.2698		
23		.2700		
24		.2700		
25		.2700		

Table 8.2-18 Inspection Data for Critical and Major Characteristics of Group No. 164 . 37 Specimens of AISI 1038 Steel
D = .375 in. ; L = 2.75 in.
Drawing No. 200 .

Date of Test: 3/7/72 Operator: J.D.S.

Specimen Number	CHARACTERISTIC			
	Hardness	d= .2700 ± .0090 in.	r= .1250 ± .002 in.	Surface Finish μ-in.
26		.2695	GO	
27		.2700		
28		.2699		
29		.2702		
30		.2705		
31		.2700		
32		.2696		
33		.2700		
34		.2695		
35		.2700		
36		.2700		
37		.2695		

Table 8.2-19 Staircase Method Data of Group No. 165 Using the R. R. Moore Machine. 36 Specimens of AISI 1038 Steel Rod with Test Section Diameter, d = .2700 in., Radius r = .250 in. Cutoff at $3X10^6$ cycles.

Date of Test	Spec. No.	Added Pan Load lbs	Alternating Stress	Cycles of Operation	Remarks*
June 26	15	23.82	35,000	1,011,000	F
27	21	21.88	33,000	3,620,000	NF
27	18	23.82	35,000	959,000	F
28	11	21.88	33,000	3,411,000	NF
28	25	23.82	35.000	1,105,000	F
29	1	21.88	33,000	1,006,000	F
29	24	19.95	31,000	3,003,000	NF
29	23	21.88	33,000	1,544,000	F
30	19	19.95	31,000	4,203,000	NF
July 3	22	21.88	33,000	3,100,000	NF
3	26	23.82	35,000	1,423,000	F
3	34	21.88	33,000	1,329,000	F
5	16	19.95	31,000	998,000	F
5	14	18.02	29,000	3,163,000	NF
5	9	19.95	31,000	10,763,000	NF
6	17	21.88	33,000	2,725,000	F
6	2	19.95	31,000	1,960,000	F
7	13	18.02	29,000	3,073,000	NF
7	8	19.95	31,000	9,115,000	NF
10	10	21.88	33,000	1,706,000	F
10	36	19.95	31,000	13,035,000	NF
11	6	21.88	33,000	1,459,000	F
11	7	19.95	31,000	7,789,000	NF
12	20	21.88	33,000	3,042,000	NF
12	31	23.82	35,000	1,282,000	F
17	4	21.88	31,000	2,571,000	F

* N F - No Failure
F - Failure

Table 8.2-19 Staircase Method Data of Group No. 165 Using the R. R. Moore Machine. 36 Specimens of AISI 1038 Steel Rod with Test Section Diameter, d = .2700 in., Radius r = .250 in. Cutoff at $3X10^6$ cycles.

Date of Test	Spec. No.	Added Pan Load lbs	Alternating Stress	Cycles of Operation	Remarks*
17	12	19.95	31,000	9,203,000	NF
18	27	21.88	33,000	2,283,000	F
19	5	19.95	31,000	3,052,000	NF
19	29	21.88	33,000	1,394,000	F
20	3	19.95	31,000	5,061,000	NF
21	30	21.88	33,000	1,027,000	F
24	28	19.95	31,000	3,883,000	NF
24	33	21.88	33,000	1,083,000	F
26	35	19.95	31,000	3,074,000	NF
26	32	21.88	33,000	1,005,000	F

* N F - No Failure
F - Failure

Table 8.2-20 Inspection Data for Critical and Major Characteristics of Group No. 165 . 36 Specimens of AISI 1038 Steel
D = .375 in. ; L = 2.75 in.
Drawing No. 200 ; Date of Inspection 6/26/72

Specimen Number	CHARACTERISTIC			
	Hardness	d= .2700 ± .0010 in.	r= .2500 ± .002 in.	Surface Finish μ-in.
1		.2709	GO	4
2		.2700		
3		.2705		
4		.2697		
5		.2700		
6		.2705		
7		.2700		
8		.2695		
9		.2698		
10		.2700		
11		.2708		
12		.2702		
13		.2700		
14		.2700		
15		.2700		
16		.2705		
17		.2693		
18		.2705		
19		.2700		
20		.2697		
21		.2698		
22		.2696		
23		.2700		
24		.2703		
25		.2700		

Table 8.2-20 Inspection Data for Critical and Major Characteristics of Group No. 165 . Specimens of AISI 1038 Steel
D = .375 in. ; L = 2.75 in.
Drawing No. 200 ; Date of Inspection 6/26/72 .

Specimen Number	CHARACTERISTIC			
	Hardness	d= .2700 ± .0010 in.	r= .250 ± .002 in.	Surface Finish μ-in.
26		.2700	GO	4
27		.2703		
28		.2698		
29		.2695		
30		.2700		
31		.2700		
32		.2705		
33		.2702		
34		.2700		
35		.2695		
36		.2698		

Table 8.2-21 Staircase Method Data of Group No. 166 Using the R. R. Moore Machine. 35 Specimens of AISI 1038 Steel Rod with Test Section Diameter, d = .2700 in., Radius r = 1.87 in. Cutoff at 3×10^6 cycles.

Date of Test	Spec. No.	Added Pan Load lbs	Alternating Stress	Cycles of Operation $\times 10^{-5}$	Remarks*
July 72 27	2	26.72	38,000	1,061,000	F
28	5	24.77	36,000	3,011,000	N F
28	6	26.72	38,000	1,682,000	F
31	7	24.78	36,000	1,310,000	F
August 1	1	22.85	34,000	3,585,000	N F
2	3	24.78	36,000	3,072,000	N F
2	8	26.72	38,000	646,000	F
2	4	24.78	36,000	835,000	F
3	16	22.85	34,000	3,047,000	N F
3	11	24.78	36,000	11,784,000	N F
4	24	26.72	38,000	20,089,000	N F
7	29	28.65	40,000	3,072,000	N F
7	14	30.58	42,000	311,000	F
7	20	28.65	40,000	587,000	F
8	10	26.72	38,000	1,855,000	F
9	18	24.78	36,000	3,120,000	N F
9	19	26.72	38,000	733,000	F
10	12	24.78	36,000	1,726,000	F
14	27	22.85	34,000	3,213,000	N F
15	32	24.78	36,000	3,521,000	N F
16	17	26.72	38,000	3,102,000	N F
18	9	28.65	40,000	655,000	F
22	31	26.72	38,000	3,292,000	N F
25	23	28.65	40,000	637,000	F
25	26	26.72	38,000	1,390,000	F
28	37	24.78	36,000	3,171,000	N F

* N F - No Failure
F - Failure

Table 8.2-21 Staircase Method Data of Group No. 166 Using the R. R. Moore Machine. 35 Specimens of AISI 1038 Steel Rod with Test Section Diameter, d = .2700 in., Radius r = 1.87 in. Cutoff at 3×10^6 cycles.

Date of Test	Spec. No.	Added Pan Load lbs	Alternating Stress	Cycles of Operation $\times 10^{-5}$	Remarks*
28	33	26.72	38,000	1,077,000	F
28	34	24.78	36,000	2,741,000	F
29	21	22.85	34,000	14,163,000	N F
30	25	24.78	36,000	4,233,000	N F
31	36	26.72	38,000	315,000	F
Sept.					
5	40	24.78	36,000	3,003,000	N F
6	35	26.72	38,000	712,000	F
6	22	24.78	36,000	3,020,000	N F
8	30	26.72	38,000	1,122,000	F
10	13	24.72	36,000	4,212,000	N F

* N F - No Failure
F Failure

Table 8.2-22 Inspection Data for Critical and Major Characteristics of Group No. 166 . 35 Specimens of AISI 1038 Steel
D = .373 in. ; L = 2.75 in.
Drawing No. 200 .

Operator: Joe Stultz Date of Test: July 27, 1972

Specimen Number	CHARACTERISTIC			
	Hardness	d= .2700 $\pm$ .0010 in.	r= 1.87 $\pm$ 002 in.	Surface Finish μ-in.
1		.2703	GO	4
2		.2705		
3		.2700		
4		.2705		
5		.2697		
6		.2700		
7		.2700		
8		.2705		
9		.2702		
10		.2700		
11		.2700		
12		.2700		
13		.2700		
14		.2705		
15		BAD SPECIMEN		
16		.2700		
17		.2700		
18		.2700		
19		.2698		
20		.2700		
21		.2705		
22		.2697		
23		.2700		
24		.2705		
25		.2700		

Table 8.2-22 Inspection Data for Critical and Major Characteristics of Group No. 166 . 35 Specimens of AISI 1038 Steel
D = .373 in. ; L = 2.75 in.
Drawing No. 200 .

Operator: Joe Stultz Date of Test: July 27, 1972

Specimen Number	CHARACTERISTIC			
	Hardness	d= .2700 ± .0010 in.	r= 1.87 ± 002 in.	Surface Finish μ-in.
26		.2700	GO	4
27		.2703		
28		BAD SPECIMEN		
29		.2708		
30		.2700		
31		.2705		
32		.2700		
33		.2695		
34		.2700		
35		.2700		
36		.2700		
37		.2700		

8 .3 AXIAL FATIGUE MACHINE DATA

Table 8.3-1 Static Ultimate Strength Test Data of Group No. 156 Using the **Tinius Olsen** Machine
35 Specimens of AISI 1018 Steel.

Date of Test: 10-24-70 Operator: R. W. Observer(s):

Specimen Number	Original Diameter in.	Original Cross Section Area in.^{2}	Yield Load lb	Yield Stress psi	Ultimate Load lb	Ultimate Stress psi	Breaking Load lb	Breaking Diameter in.	Breaking Area in.	Breaking Stress psi
1	.2500	.0491	2,250	45,825	2,920	59,470	1,750	.122	.0117	149,573
2	.2492	.0487	2,230	45,791	2,930	60,164	1,720	.119	.0111	154,955
3	.2497	.0490	2,300	46,939	2,960	60,408	1,750	.121	.0115	152,174
4	.2496	.0490	2,250	45,918	2,940	60,000	1,690	.124	.0121	139,669
5	.2497	.0490	2,260	46,122	2,940	60,000	1,720	.121	.0115	149,565
6	.2493	.0487	2,260	46,407	2,970	60,986	1,750	.124	.0121	144,628
7	.2494	.0487	2,240	45,996	2,960	60,780	1,710	.121	.0115	148,696
8	.2491	.0487	2,270	46,612	2,960	60,780	1,710	.123	.0119	143,697
9	.2500	.0491	2,230	45,418	2,910	59,267	1,720	.122	.0117	147,008
10	.2496	.0490	2,220	45,306	3,000	61,224	1,730	.120	.0113	153,097
11	.2500	.0491	2,210	45,010	2,940	59,878	1,750	.122	.0117	149,573
12	.2493	.0487	2,250	46,201	2,930	60,164	1,730	.121	.0115	150,435
13	.2497	.0490	2,270	46,327	2,980	60,816	1,740	.121	.0115	151,304
14	.2503	.0491	2,300	46,843	2,970	60,489	1,690	.125	.0123	137,398
15	.2503	.0491	2,260	46,029	2,970	60,489	1,720	.121	.0115	149,565
16	.2484	.0484	2,270	46,901	2,950	60,331	1,720	.121	.0115	149,565
17	.2503	.0491	2,230	45,418	2,970	60,489	1,730	.124	.0121	142,925
18	.2500	.0491	2,130	43,381	2,900	59,063	1,720	.120	.0113	152,212
19	.2495	.0489	2,200	44,990	2,970	60,736	1,730	.122	.0117	147,863
20	.2494	.0488	2,200	45,082	3,000	61,475	1,730	.122	.0117	147,863
21	.2489	.0486	2,230	45,885	2,970	61,111	1,760	.121	.0115	153,043

Table 8.3-1 Static Ultimate Strength Test Data of Group No. 156 Using the **Tinius Olsen** Machine
35 Specimens of AISI 1018 Steel.

Date of Test: 10-24-70 Operator: R. W. Observer(s):

Specimen Number	Original Diameter in.	Original Cross Section Area in.^{2}	Yield Load lb	Yield Stress psi	Ultimate Load lb	Ultimate Stress psi	Breaking Load lb	Breaking Diameter in.	Breaking Area in.	Breaking Stress psi
22	.2497	.0489	2,250	46,012	2,970	60,736	1,770	.127	.0127	139,370
23	.2506	.0493	2,250	45,639	2,990	60,649	1,740	.122	.0117	148,718
24	.2492	.0489	2,270	46,421	2,990	61,145	1,760	.120	.0113	155,752
25	.2494	.0488	2,220	45,492	2,980	61,066	1,750	.121	.0115	152,174
26	.2491	.0487	2,210	45,380	2,980	61,191	1,740	.124	.0121	143,802
27	.2497	.0489	2,250	46,012	3,010	61,554	1,750	.120	.0113	154,867
28	.2486	.0485	2,180	44,948	2,900	59,794	1,680	.125	.0123	136,585
29	.2486	.0485	2,200	45,361	2,930	60,412	1,720	.019	.0111	154,955
30	.2493	.0488	2,200	45,082	2,960	60,656	1,760	.124	.0121	145,455
31	.2494	.0488	2,180	44,672	2,910	59,631	1,730	.124	.0121	142,975
32	.2491	.0487	2,180	44,764	2,930	60,164	1,690	.122	.0117	144,444
33	.2497	.0489	2,150	43,967	2,900	59,305	1,720	.121	0.115	149,565
34	.2496	.0489	2,210	45,194	2,980	60,941	1,730	.121	.0115	150,435
35	.2491	.0487	2,200	45,174	2,920	59,959	1,680	.117	.0108	155,555

Yield Stress

Mean* = 45,600 psi
Std. Dev ** = 780 psi

Ultimate Stress

Mean* = 60,400 psi
Std. Dev.** = 630 psi

Breaking Stress

Mean* = 148,300 psi
Std. Dev.** = 5,160 psi

* rounded to nearest 100 psi
** rounded to nearest 10 psi

Table 8.3-2 Test Data for Hardness and Ultimate Strength Elongation of Group No. 156 35 Specimens of AISI 1018 Steel. D = .373 in. ; L = 9.0 in. + 1/16 Drawing No. 100 ; Date of Test 10-22-70 .

Specimen Number	CHARACTERISTIC			
	Rockwell Hardness B Scale	Brinell Hardness BHN	ΔL on 2 in. Gage Length	Elongation %
1	72	126	0.988	24.4
2	69	118	B.O.	
3	72	126	0.655	32.7
4	73	128	0.548	27.4
5	69	118	0.593	29.6
6	70	121	0.616	30.8
7	74	131	0.634	31.7
8	73	128	0.597	29.9
9	75	134	0.598	29.9
10	74	131	0.588	29.4
11	72	126	B.O.	
12	76	137	0.552	27.6
13	74	131	0.560	28.0
14	70	121	0.530	26.6
15	71	124	0.564	28.7
16	74	131	0.564	28.7
17	66	111	0.672	33.6
18	70	121	0.630	31.5
19	71	124	0.538	26.9
20	72	126	0.639	31.9
21	70	121	0.519	25.9
22	73	128	0.540	27.0
23	74	131	0.559	27.9
24	72	126	0.514	25.7
25	74	131	0.582	29.1

Table 8.3-2 Test Data for Hardness and Ultimate Strength Elongation of Group No. 156 35 Specimens of AISI 1018 Steel. D = .373 in. ; L = 9 in. + 1/16 Drawing No. 100 ; Date of Test 10-22-70 .

Specimen Number	CHARACTERISTIC			
	Rockwell Hardness B Scale	Brinell Hardness BHN	ΔL on 2 in. Gage Length	Elongation %
26	74	131	0.543	27.2
27	73	128	0.583	29.2
28	72	126	0.500	25.0
29	74	131	0.544	27.2
30	74	131	0.579	28.9
31	73	128	0.539	26.9
32	70	121	0.570	28.5
33	74	131	0.570	28.5
34	73	128	0.632	31.6
35	72	126	B.O.	

Table 8.3-3 Staircase Method Data of Group No. 159. Using the Axial Fatigue Machine.
35 Specimens of AISI 1018 Steel Rod with Test Section Diameter, $d = 0.075$ in., Radius $r = 2.70$ in. Stress Ratio $r_s = 1.0$. Cutoff at 2×10^6 Cycles.

Date of Test	Spec. No.	Mean Load lb	Mean Stress psi	Alternating Load lb	Alternating Stress psi	Stress Vector psi	Cycles of Operation	Operator	Remarks*
June 72 11	1	94	21,281	94	21,281	30,096	2,017,000	A.N.V.	N F
12	2	97	21,960	97	21,960	31,057	1,030,000		F
13	3	94	21,281	94	21,281	30,096	2,612,000		N F
14	4	97	21,960	97	21,960	31,057	2,021,000		N F
17	5	100	22,639	100	22,639	32,017	2,325,000		N F
18	6	103	23,319	103	23,319	32,978	1,471,000		F
19	7	100	22,639	100	22,639	32,017	663,000		F
20	8	97	21,960	97	21,960	31,057	2,394,000		N F
21	9	100	22,639	100	22,639	32,017	500,000		F
21	10	97	21,960	97	21,960	31,057	2,025,000		N F
21	11	100	22,639	100	22,639	32,017	2,301,000		N F
23	12	103	23,319	103	23,319	32,978	2,321,000		N F
24	13	106	23,998	106	23,998	33,938	340,000		F
24	14	103	23,319	103	23,319	32,978	413,000		F
26	15	100	22,639	100	22,639	32,017	333,000		F
26	16	97	21,960	97	21,960	31,057	2,035,000		N F
27	17	100	22,639	100	22,639	32,017	366,000		F
27	18	97	21,960	97	21,960	31,057	2,122,000		N F
28	19	100	22,639	100	22,639	32,017	2,001,000		N F
29	20	103	23,319	103	23,319	32,978	841,000		F

* N F - No Failure
F - Failure

Table 8.3-3 Staircase Method Data of Group No. 159. Using the Axial Fatigue Machine.
35 Specimens of AISI 1018 Steel Rod with Test Section Diameter, d = 0.075 in.,
Radius r = 2.70 in. Stress Ratio r_s = 1.0 . Cutoff at 2×10^6 Cycles.

Date of Test	Spec. No.	Mean Load lb	Mean Stress psi	Alternating Load lb	Alternating Stress psi	Stress Vector psi	Cycles of Operation	Operator	Remarks*
June 72 29	20	103	23,319	103	23,319	32,978	841,000	A N V	F
30	21	100	22,639	100	22,639	32,017	650,000		F
30	22	97	21,960	97	21,960	31,057	2,347,000		N F
July 72 1	23	100	22,639	100	22,639	32,017	3,133,000		N F
3	24	103	23,319	103	23,319	32,978	711,000		F
3	25	100	22,639	100	22,639	32,017	2,061,000		N F
4	26	103	23,319	103	23,319	32,978	432,000		F
5	27	100	22,639	100	22,639	32,017	2,439,000		N F
6	28	103	23,319	103	23,319	32,978	1,328,000		F
7	29	100	22,639	100	22,639	32,017	137,000		F
Sept. 72 23	30	97	21,960	97	21,960	31,057	2,004,000		N F
24	31	100	22,639	100	22,639	32,017	2,717,000		N F
25	32	103	23,319	103	23,319	32,978	2,437,000		N F
26	33	106	23,998	106	23,998	33,938	1,849,000		F
27	34	103	23,319	103	23,319	32,978	1,719,000		F
28	35	100	22,639	100	22,639	32,017	2,934,000		N F

* N F - No Failure
F - Failure

Table 8.3-4 Staircase Method Data of Group No.160 . Using the Axial Fatigue Machine.
35 Specimens of AISI 1018 Steel Rod with Test Section Diameter, d = 0.075 in.,
Radius r = 2.70 in. Stress Ratio r_s = 2.0 . Cutoff at 2 x 10^6 Cycles.

Date of Test	Spec. No.	Mean Load lb	Mean Stress psi	Alternating Load lb	Alternating Stress psi	Stress Vector psi	Cycles of Operation	Oper-ator	Remarks*
Dec. 71 17	1	55.5	12,567	111.0	25,133	28,100	7,820,000	R.W.	N F
20	2	57.5	13,014	115.0	26,028	29,100	881,000	R.W.	F
21	3	55.5	12,567	111.0	25,133	28,100	671,000	R.W	F
22	4	53.5	12,120	107.1	24,239	27,100	2,385,000	R.W.	N F
23	5	55.5	12,567	111.0	25,133	28,100	646,000	R.W.	F
Jan.72 3	6	53.5	12,120	107.1	24,239	27,100	2,346,000	R.W.	N F
4	7	55.5	12,567	111.0	25,133	28,100	2,459,000	R.W.	N F
5	8	57.5	13,014	115.0	26,028	29,100	119,000	R.W.	F
6	9	55.5	12,567	111.0	25,133	28,100	568,100	R.W.	F
Feb.72 25	10	53.5	12,120	107.1	24,239	27,100	304,000	A.N.V.	F
26	11	51.5	11,672	103.1	23,344	26,100	4,917,000	A.N.V.	N F
29	12	53.5	12,120	107.1	24,239	27,100	2,633,000	A.N.V.	N F
Mar.72 1	13	55.5	12,567	111.0	25,133	28,100	2,462,000	A.N.V	N F
2	14	57.5	13,014	115.0	26,028	29,100	638,000	A.N.V	F
3	15	55.5	12,567	111.0	25,133	28,100	2,472,000	A.N.V	N F
4	16	57.5	13,014	115.0	26,028	29,100	3,245,000	A.N.V	N F
17	17	59.5	13,461	118.9	26,922	30,100	315,000	A.N.V	F
18	18	57.5	13,014	115.0	26,028	29,100	582,000	A.N.V	F
May 72 19	19	55.5	12,567	111.0	25,133	28,100	93,000	A.N.V	F
22	20	53.5	12,120	107.1	24,239	27,100	247,000	A.N.V	F

* N F - No Failure
F - Failure

Table 8.3-4 Staircase Method Data of Group No.160 . Using the Axial Fatigue Machine. 35 Specimens of AISI 1018 Steel Rod with Test Section Diameter, d = 0.075 in., Radius r = 2.70 in. Stress Ratio r_s = 2.0 . Cutoff at 2×10^6 Cycles.

Date of Test	Spec. No.	Mean Load lb	Mean Stress psi	Alternating Load lb	Alternating Stress psi	Stress Vector psi	Cycles of Operation	Operator	Remarks*
23	21	51.5	11,672	103.1	23,344	26,100	2,660,000	A.N.V.	N F
24	22	53.5	12,120	107.1	24,239	27,100	2,168,000	A.N.V.	N F
25	23	55.5	12,567	111.0	25,133	28,100	135,000	A.N.V.	F
26	24	53.5	12,120	107.1	24,239	27,100	627,000	A.N.V.	F
28	25	51.5	11,672	103.1	23,344	26,100	2,590,000	A.N.V.	N F
29	26	53.5	12,120	107.1	24,239	27,100	2,569,000	A.N.V.	N F
30	27	55.5	12,567	111.0	25,133	28,100	420,000	A.N.V.	F
July 72 23	28	53.5	12,120	107.1	24.239	27,100	568,000	A.N.V.	F
Aug. 72 8	29	51.5	11,672	103.1	23,334	26,100	2,315,000	A.N.V.	N F
9	30	53.5	12,120	107.1	24,239	27,100	2,666,000	A.N.V.	N F
10	31	55.5	12,567	111.0	25,133	28,100	2,427,000	A.N.V.	N F
11	32	57.5	13,014	115.0	26,028	29,100	301,000	A.N.V.	F
11	33	55.5	12,567	111.0	25,133	28,100	1,692,000	A.N.V.	F
13	34	53.5	12,120	107.1	24,239	27,100	2,269,100	A.N.V.	N F
14	35	55.5	12,567	111.0	25,133	28,100	1,098,000	A.N.V.	F

* N F - No Failure
F - Failure

Table 8.3-5 Staircase Method Data of Group No. 161. Using the Axial Fatigue Machine. 36 Specimens of AISI 1018 Steel Rod with Test Section Diameter, $d = 0.075$ in., Radius $r = 2.70$ in. Stress Ratio $r_s = \infty$. Cutoff at 2×10^6 Cycles.

Date of Test	Spec. No.	Mean Load lb	Mean Stress psi	Alternating Load lb	Alternating Stress psi	Stress Vector psi	Cycles of Operation	Operator	Remarks*
OCT. 71 19	1	0	0	103.3	23,386	23,386	2,855,000	R.W.	N F
26	2			107.7	24,383	24,383	2,689,000	R.W.	N F
Nov. 71 4	3			112.1	25,379	25,379	689,000	R.W.	F
5	4			107.7	24,383	24,383	7,695,000	R.W.	N F
17	5			112.1	25,379	25,379	2,637,000	R.W.	N F
18	6			116.5	26,375	26,375	2,699,000	R.W.	N F
22	7			120.9	27,371	27,371	20,000	R.W.	F
23	8			116.5	26,375	26,375	585,000	R.W.	F
24	9			112.1	25,379	25,379	7,645,000	R.W.	N F
27	10			116.5	26,375	26,375	5,235,000	R.W.	N F
29	11			120.9	27,371	27,371	178,000	R.W.	F
30	12			116.5	26,375	26,375	681,000	R.W.	F
Dec. 71 1	13			112.1	25,379	25,379	2,593,000	R.W.	N F
2	14			116.5	26,375	26,375	109,000	R.W.	F
2	15			112.1	25,379	25,379	405,000	R.W.	F
3	16			107.7	24,383	24,383	2,364,000	R.W.	N F
4	17			112.1	25,379	25,379	5,552,000	R.W.	N F
6	18			116.1	26,375	26,375	186,000	R.W.	F
7	19			112.1	25,379	25,379	2,638,000	R.W.	N F
8	20			116.5	26,375	26,375	2,302,000	R.W.	N F

* N F - No Failure

F - Failure

Table 8.3-5 Staircase Method Data of Group No.161 . Using the Axial Fatigue Machine.
36 Specimens of AISI 1018 Steel Rod with Test Section Diameter, d = 0.075 in.,
Radius $r = 2.70$ in. Stress Ratio $r_s = \infty$. Cutoff at 2×10^6 Cycles.

Date of Test	Spec. No.	Mean Load lb	Mean Stress psi	Alternating Load lb	Alternating Stress psi	Stress Vector psi	Cycles of Operation	Operator	Remarks*
13	21	0	0	120.9	27,371	27,371	469,000	R.W.	F
Aug. 72 15	22			116.5	26,375	26,375	1,415,000	A.N.V.	F
16	23			112.1	25,379	25,379	2,109,000	A.N.V.	N F
17	24			116.5	26,375	26,375	1,917,000	A.N.V.	F
19	25			112.1	25,379	25,379	2,616,000	A.N.V.	N F
20	26			116.5	26.375	26.375	2,012,000	A.N.V.	N F
21	27			120.9	27,371	27,371	320,000	A.N.V.	F
22	28			116.5	26,375	26,375	2,899,000	A.N.V.	N F
24	29			120.9	27,371	27,371	1,763,000	A.N.V.	F
Sept. 72 18	30			116.5	26,375	26,375	2,075,000	A.N.V.	N F
19	31			120.9	27,371	27,371	1,069,000	A.N.V.	F
20	32			116.5	26,375	26,375	994,000	A.N.V.	F
21	33			112.1	25,379	25,379	2,416,000	A.N.V.	N F
29	34			116.5	26,375	26,375	2,212,000	A.N.V.	N F
Oct. 72 2	35			120.9	27,371	27,371	929,000	A.N.V.	F
5	36			116.5	26,375	26,375	2,237,000	A.N.V.	N F

*N F - No Failure
F - Failure

Table 8.3-6 Staircase Method Data of Group No. 63. Using the Axial Fatigue Machine.
25 Specimens of AISI 4130 Steel Rod with Test Section Diameter, d = 0.047 in.,
Radius r = 2.70 in. Stress Ratio r_s = 0.2 . Cutoff at 2 x 10^6 Cycles.

Date of Test	Spec. No.	Mean Load lb	Mean Stress psi	Alternating Load lb	Alternating Stress psi	Stress Vector psi	Cycles of Operation	Operator	Remarks*
Feb. 71 27	12	138	79,552	27.6	15,910	81,128	444,000	W.E.R.	F
28	30	134	77,246	26.8	15,449	78,776	2,257,000		N F
Mar. 71 1	31	138	79,552	27.6	15,910	81,128	2,078,000		N F
3	16	142	81,858	28.4	16,371	83,479	10,000		F
3	8	138	79,552	27.6	15,910	81,128	2,325,000		N F
4	11	142	81,858	28.4	16,371	83,479	5,000		F
4	5	138	79,552	27.6	15,910	81,128	2,020,000		N F
5	9	142	81,858	28.4	16,371	83,479	123,000		F
5	7	138	79,552	27.6	15,910	81,128	4,000		F
5	20	134	77,246	26.8	15,449	78,776	5,945,000		N F
7	36	138	79,552	27.6	15,910	81,128	3,000		F
7	37	134	77,246	26.8	15,449	78,776	2,118,000		N F
8	24	138	79,552	27.6	15,910	81,128	891,000		F
9	15	134	77,246	26.8	15,449	78,776	2,404,000		N F
10	19	138	79,552	27.6	15,910	81,128	2,019,000		N F
11	23	142	81,858	28.4	16,371	83,479	3,000		F
11	46	138	79,552	27.6	15,910	81,128	2,583,000		N F
12	42	142	81,858	28.4	16,371	83,479	14,000		F
12	25	138	79,552	27.6	15,910	81,128	259,000		F
12	41	134	77,246	26.8	15,449	78,776	2,167,000		N F

* NF - No Failure
F - Failure

Table 8.3-6 Staircase Method Data of Group No. 63 . Using the Axial Fatigue Machine.
25 Specimens of AISI 4130 Steel Rod with Test Section Diameter, d = 0.047 in.,
Radius r = 2.70 in. Stress Ratio r_s = 0.2 . Cutoff at 2 x 10^6 Cycles.

Date of Test	Spec. No.	Mean Load lb	Mean Stress psi	Alternating Load lb	Alternating Stress psi	Stress Vector psi	Cycles of Operation	Operator	Remarks*
13	27	138	79,552	27.6	15,910	81,128	3,000	W.E.R.	F
15	28	134	77,246	26.8	15,449	78,776	2,447,000		N F
16	32	138	79,552	27.6	15,910	81,128	2,000,000		N F
17	48	142	81,858	28.4	16,371	83,479	3,000		F
17	26	138	79,552	27.6	15,910	81,128	9,000		F

* NF - No Failure
F - Failure

9.0 REDUCED TEST DATA

This section presents the results of processing test data experimental test data with the data reduction and analysis computer programs. Calibration data are presented in summary tables with the parameters calculated for the normal distribution. Results of cycles-to-failure testing are shown in histogram overscribed with distribution curves for the normal, lognormal (base e), and Weibull distributions. The calculated distribution parameters and goodness-of-fit test results are listed below the curves.

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9.1 WIRE FATIGUE MACHINE DATA

Table 9.1-1 Angle of Deflection Vs. Mean Measured Strain in Wire Fatigue Research Machine Calibration Specimen for Each One of the Four Machines.

Angle of Deflection Degrees	Mean Strain* - (μ-in/in.)			
	Machine #1	Machine #2	Machine #3	Machine #4
0	0	0	0	0
4	137.5	116.5	139	111.5
8	280.5	274.5	323	260.5
12	493.5	621	681	546.5
16	848	1,001	1012.5	880
18	1,025	1175.5	1,175	1056.5
20	1,202	1,346	1342.5	1,219
22	1365.5	1,517	1,501	1374.5
24	1,530	1,686	1,663	1539.5
26	1,679	1,834	1,814	1,696

*Data came from Tables 1 thru 4.

Table 9.1-2 Summary of Static Axial Calibration Data For The 0.040 in. Diameter Wire Specimen Used in Calibrating the Wire Fatigue Machines.

Pan Weight lb	Stress psi	Group #1 μ - in/in		Group #2 μ - in/in		Group #3 μ - in/in		Group #4 μ - in/in	
		L*	UL**	L	UL	L	UL	L	UL
0.00	0	0	0	0	0	0	0	0	0
7.00	5,499	26	28	25	27	25	29	28	29
10.50	8,248	71	69	67	72	69	75	75	76
14.00	10,997	117	121	116	118	115	122	121	122
17.50	13,746	168	174	166	170	165	173	169	174
21.00	16,496	215	222	213	219	212	223	218	225
24.50	19,245	265	272	260	272	261	272	270	276
28.00	21,995	317	323	316	320	311	321	320	324
31.50	24,744	371	374	368	372	364	374	374	378
35.00	27,493	423	426	420	424	411	414	426	430

*Loading cycle

**Unloading cycle

Table 9.1-3 Calculation of The Standard Deviation For Strain For Each Stress Level Given in Table 7.

5,499 psi		8,248 psi		10,997 psi		13,746 psi		16,496 psi	
Strain in μ-in/in		Strain in μ-in/in		Strain in μ-in/in		Strain in μ-in/in		Strain in μ-in/in	
$(X_i - \overline{X})$	$(X_i - \overline{X})^2$	$(X_i - \overline{X})$	$(X_i - \overline{X})^2$	$(X_i - \overline{X})$	$(X_i - \overline{X})^2$	$(X_i - \overline{X})$	$(X_i - \overline{X})^2$	$(X_i - \overline{X})$	$(X_i - \overline{X})^2$
-1.125	1.265	- .75	.5625	-2	4	-1.875	3.515	-3.375	11.390
.875	.765	-2.75	7.5625	2	4	4.125	17.015	3.625	13.140
-2.125	4.515	-2.75	22.5625	-3	.9	-3.875	15.015	-5.375	28.890
- .125	.015	.25	.0625	-1	1	.125	.015	.625	.390
-2.125	4.515	-2.75	7.5625	-4	16	-4.875	23.765	-6.375	40.640
1.875	3.515	3.25	10.5625	3	9	3.125	9.765	4.625	21.390
.875	.765	3.25	10.5625	2	4	- .875	.765	- .375	.140
1.875	3.515	4.25	18.0625	3	9	4.125	17.015	6.625	43.890
$\frac{\Sigma(X-\overline{X})^2}{n} = 2.358$		$\frac{\Sigma(X-\overline{X})^2}{n} = 9.687$		$\frac{\Sigma(X-\overline{X})^2}{n} = 7$		$\frac{\Sigma(X-\overline{X})^2}{n} = 2.645$		$\frac{\Sigma(X-\overline{X})^2}{n} = 19.98$	
Std. Dev.=1.5		Std.Dev.= 3.1		Std. Dev. = 2.6		Std.Dev.= 3.3		Std.Dev. = 4.5	

Table 9.1-3 Continued

19,245 psi		21,995 psi		24,744 psi		27,493 psi	
Strain in μ-in/in		Strain in μ-in/in		Strain in μ-in/in		Strain in μ-in/in	
$(X_i-\overline{X})$	$(X_i-\overline{X})^2$	$(X_i-\overline{X})$	$(X_i-\overline{X})^2$	$(X_i-\overline{X})$	$(X_i-\overline{X})^2$	$(X_i-\overline{X})$	$(X_i-\overline{X})^2$
-3.5	12.25	-2	4	- .875	.765	1.25	1.625
3.5	12.25	4	16	2.125	4.515	4.25	18.0625
-8.5	72.25	-3	9	-3.875	15.01	-1.75	3.0625
3.5	12.25	1	1	.125	.0156	2.25	5.0625
-7.5	56.25	-8	64	-7.875	62.01	-10.75	115.5625
3.5	12.25	2	4	2.125	4.515	7.75	60.0625
1.5	2.25	1	1	2.125	4.515	4.25	18.0625
7.5	56.25	5	25	6.125	39.51	8.25	68.0625
$\frac{\Sigma(X-\overline{X})^2}{n} = 29.5$		$\frac{\Sigma(X-\overline{X})^2}{n} = 15.5$		$\frac{\Sigma(X-\overline{X})^2}{n} = 16.356$		$\frac{\Sigma(X-\overline{X})^2}{n} = 36.18$	
Std.Dev. = 5.4		Std.Dev. = 3.9		Std.Dev. = 4.0		Std.Dev. = 6.0	

Table 9.1-4 Static Axial Stress Versus Measured Strain for The Wire Specimen Used in Calibrating The Wire Fatigue Research Machines. Mean wire diameter - $\overline{D}$ = .040263 in.

Pan Weight Pounds	Static Stress psi	Mean Strain* μ - in/in	Standard Deviation of Strain μ - in/in
0	0	0	0
7.00	5,499	27	1.5
10.50	8,248	72	3.1
14.00	10,997	119	2.6
17.50	13,746	170	3.3
21.00	16,496	218	4.5
24.50	19,245	269	5.4
28.00	21,995	319	3.9
31.50	24,744	372	4.0
35.00	27,493	422	6.0

*Average of values given in Table 9.1-5

Table 9.1-5 Actual Specimen Stress Versus Test Specimen Deflection Angle for Each Wire Fatigue Research Machine.

Angle of Deflection Degree	Stress in psi Using The Mean Strain From Calibration And The Static Axial Stress Versus Strain Calibration Chart.			
	Machine #1	Machine #2	Machine #3	Machine #4
0	0	0	0	0
4	11,882	10,714	11,965	10,442
8	19,801	19,469	22,154	18,693
12	31,597	38,657	41,980	34,532
16	51,228	59,701	60,338	53,001
18	61,030	69,365	69,337	62,775
20	70,833	78,807	78,613	71,774
22	79,887	88,277	87,391	80,385
24	88,997	97,636	96,362	89,523
26	97,248	105,832	104,725	98,190

Table. 9.1-6 Reduced Data for Group 87 , AISI 1038 Steel, Wire Fatigue Machine No. 2 .

Staircase method at 2×10^6 cycles
Specimen: D = 0.0626
Number of Useful Specimens: 69

Alternating Stress psi	i	n_i Failures	in_i	$i^2 n_i$
57,500	5	4	20	100
55,000	4	8	32	128
52,500	3	13	39	117
50,000	2	4	8	16
47,500	1	3	3	3
45,000	0	1	0	0
		N = 33	A = 102	B = 364

d = stress increment = 2,500 psi

X_o = lowest stress level = 45,000 psi

$\overline{X}$ = mean (estimate)

$\overline{X} = X_o + d[A/N - 1/2] = 45,000 + 2,500 \left[\frac{102}{33} - \frac{1}{2} \right]$

$\overline{X}$ = 51,477 psi ≅ 51,000 psi*

s = standard deviation (estimate)

$s = 1.620\, d[(NB-A^2)/N^2 + 0.029] = 1.620\,(2,500) \left[\frac{(33)\,(364) - (102)^2}{(33)^2} + 0.029 \right]$

s = 6,097.6 psi ≅ 6,100 psi**

This information supersedes the information reported in Table 15.3.1.2.1, p. 392 of [IV] .

* Rounded off to nearest 1,000 psi

** Rounded off to nearest 100 psi

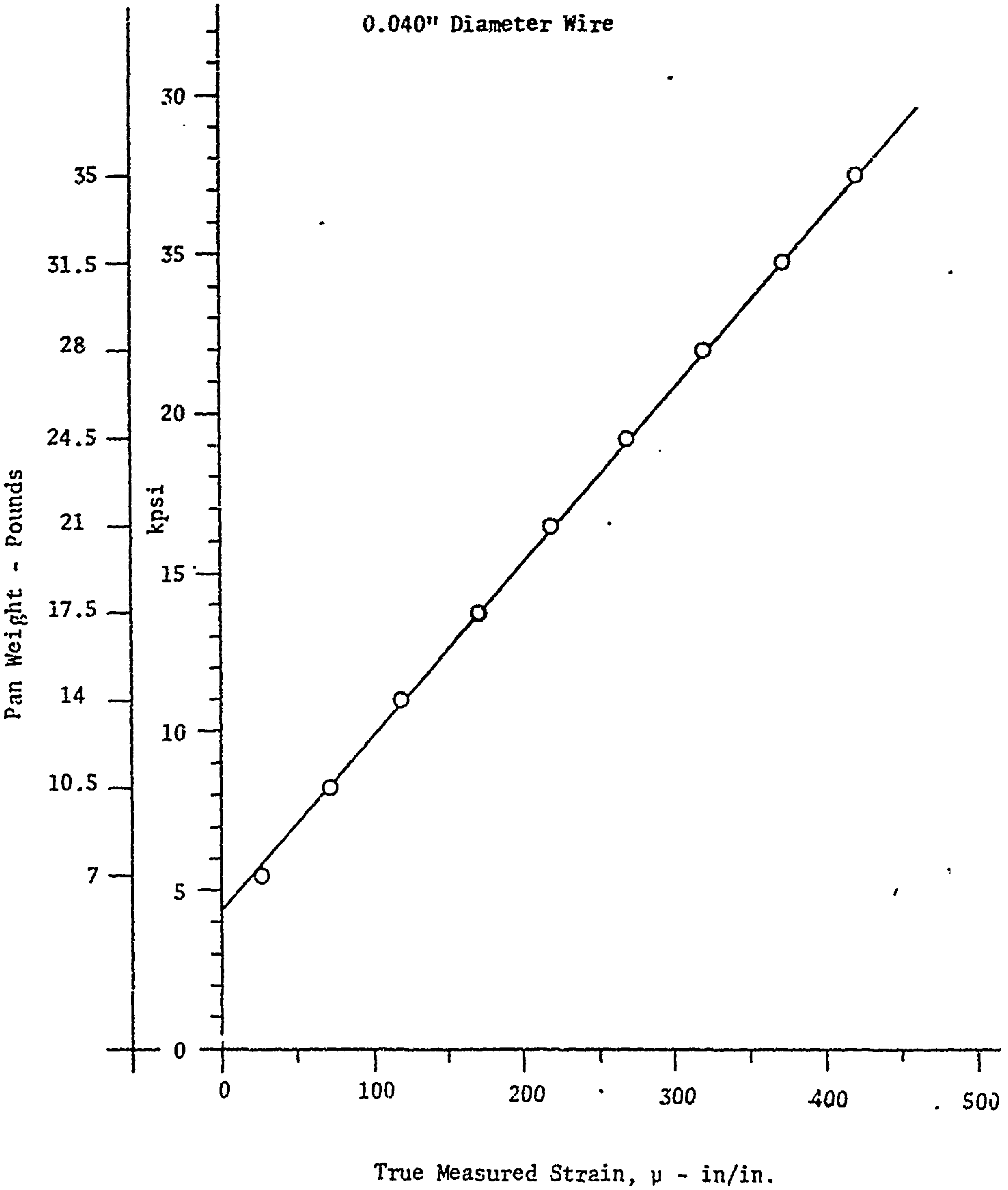
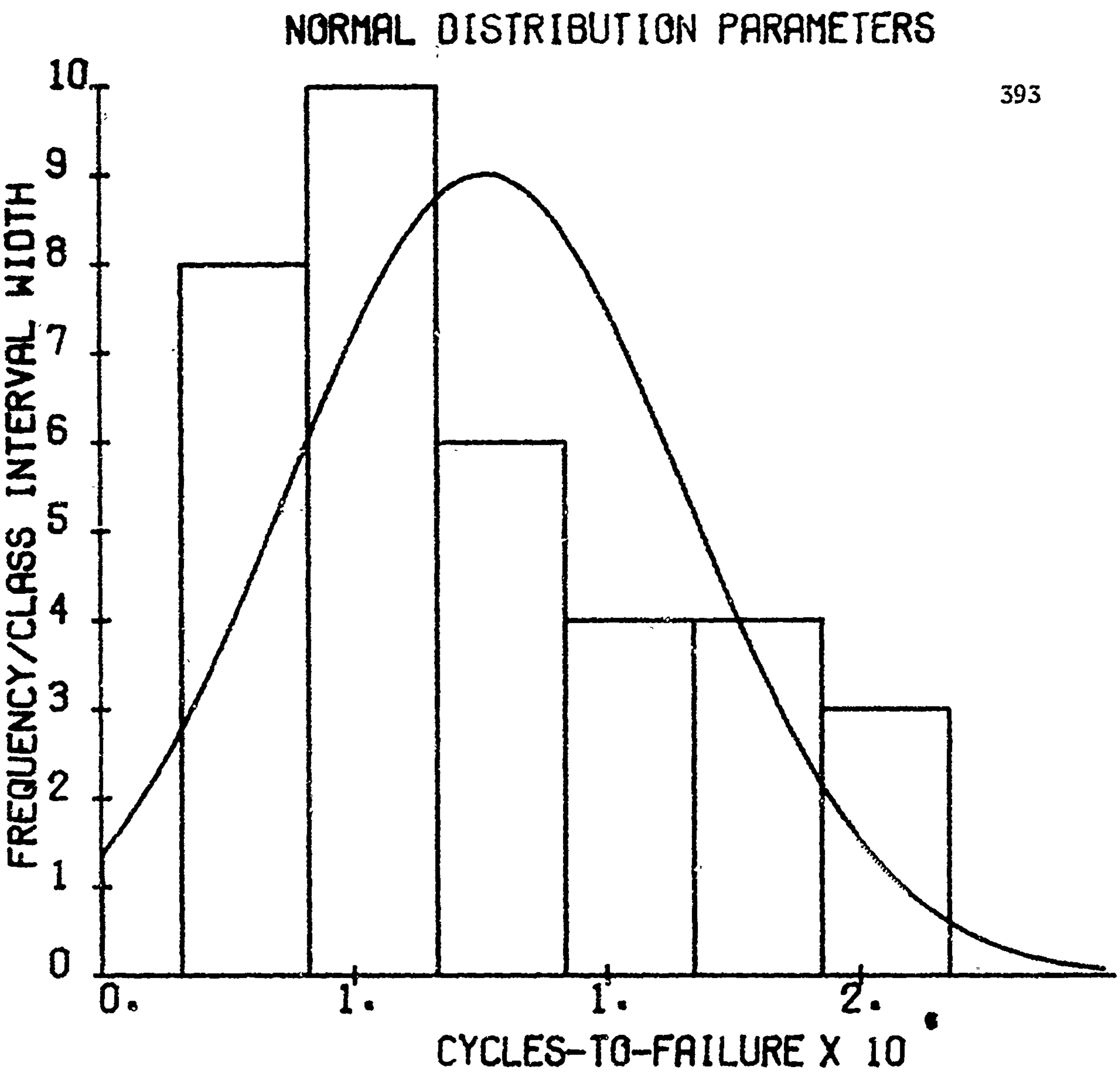


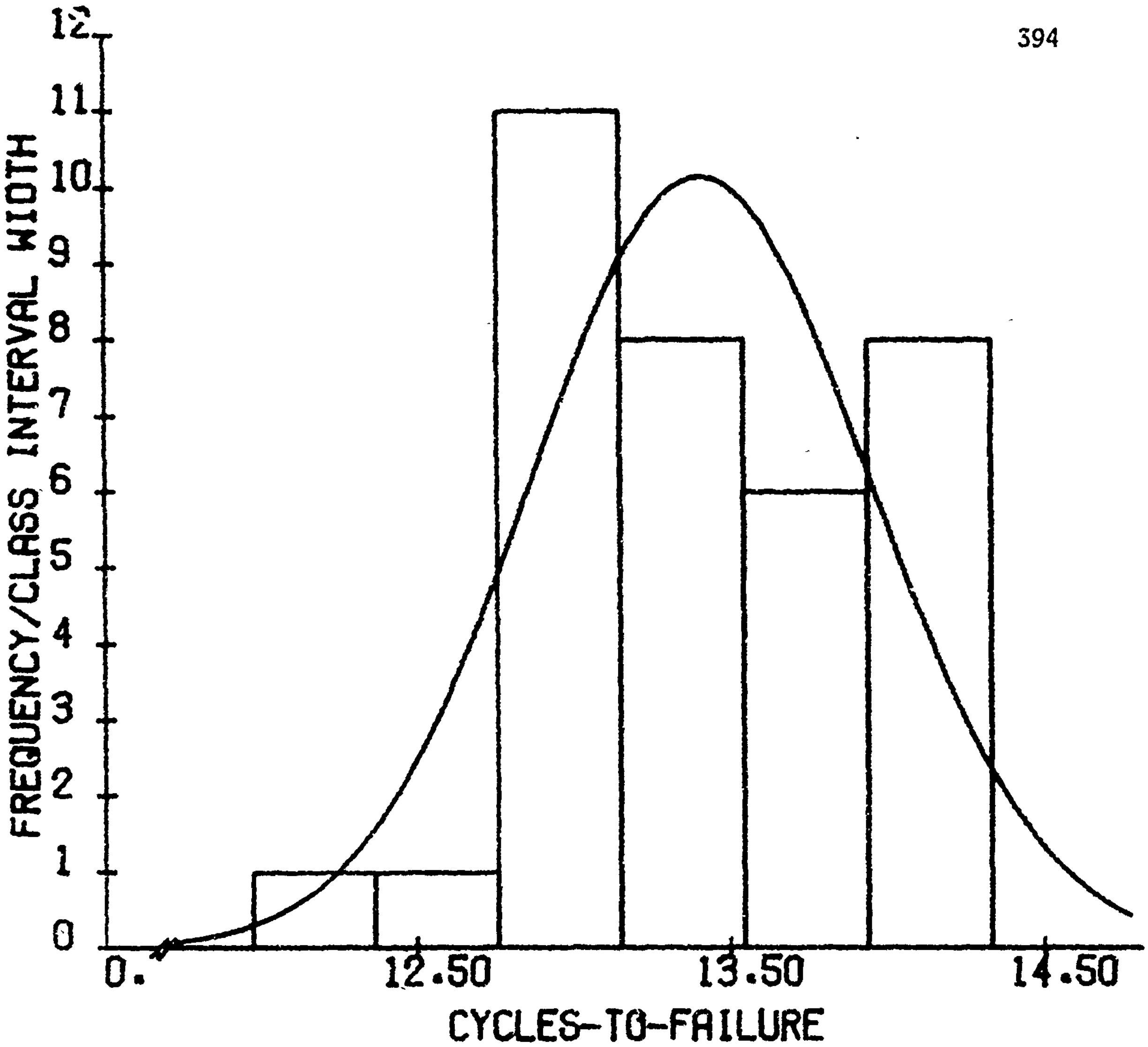
Fig. 9.1-1 Calibration Chart of Stress Vs. Measured Strain for Calibration of Fatigue Research Machines (See Table 9).



MEAN VALUE:	760785.7	CYCLES
STANDARD DEVIATION:	392078.4	CYCLES
KOLMOGOROV-SMIRNOV TEST:	0.132	
CHI-SQUARED TEST:	3.870	
SKEWNESS:	0.692	
KURTOSIS:	2.452	

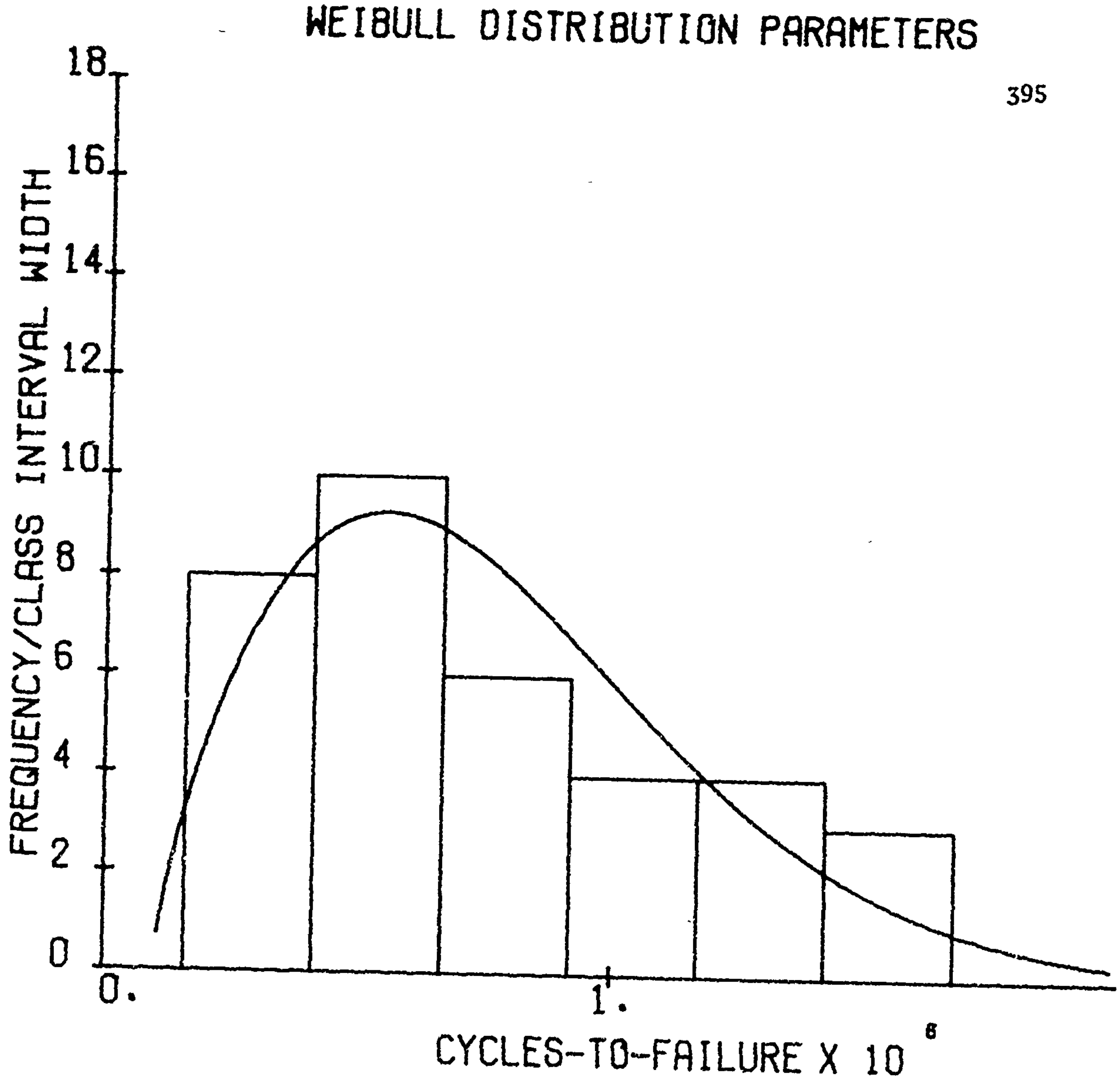
FIG. 9.1-2 CYCLES-TO-FAILURE DIST OF GROUP NO. 129 USING WIRE FATIGUE MACHINE NO. 1 FOR 35 SPECIMENS OF .040 IN. DIAMETER AISI 4130 STEEL WIRE. FIXED ALTERNATING STRESS LEVEL OF 67,700 PSI. BEND ANGLE 19.5 DEGREES. COAST-DOWN CYCLES 100.

LOG NORMAL DISTRIBUTION PARAMETERS



MEAN VALUE: 13.408 CYCLES
STANDARD DEVIATION: 0.541 CYCLES
KOLMOGOROV-SMIRNOV TEST: 0.058
CHI-SQUARED TEST: 2.208
SKEWNESS: -0.288
KURTOSIS: 2.805

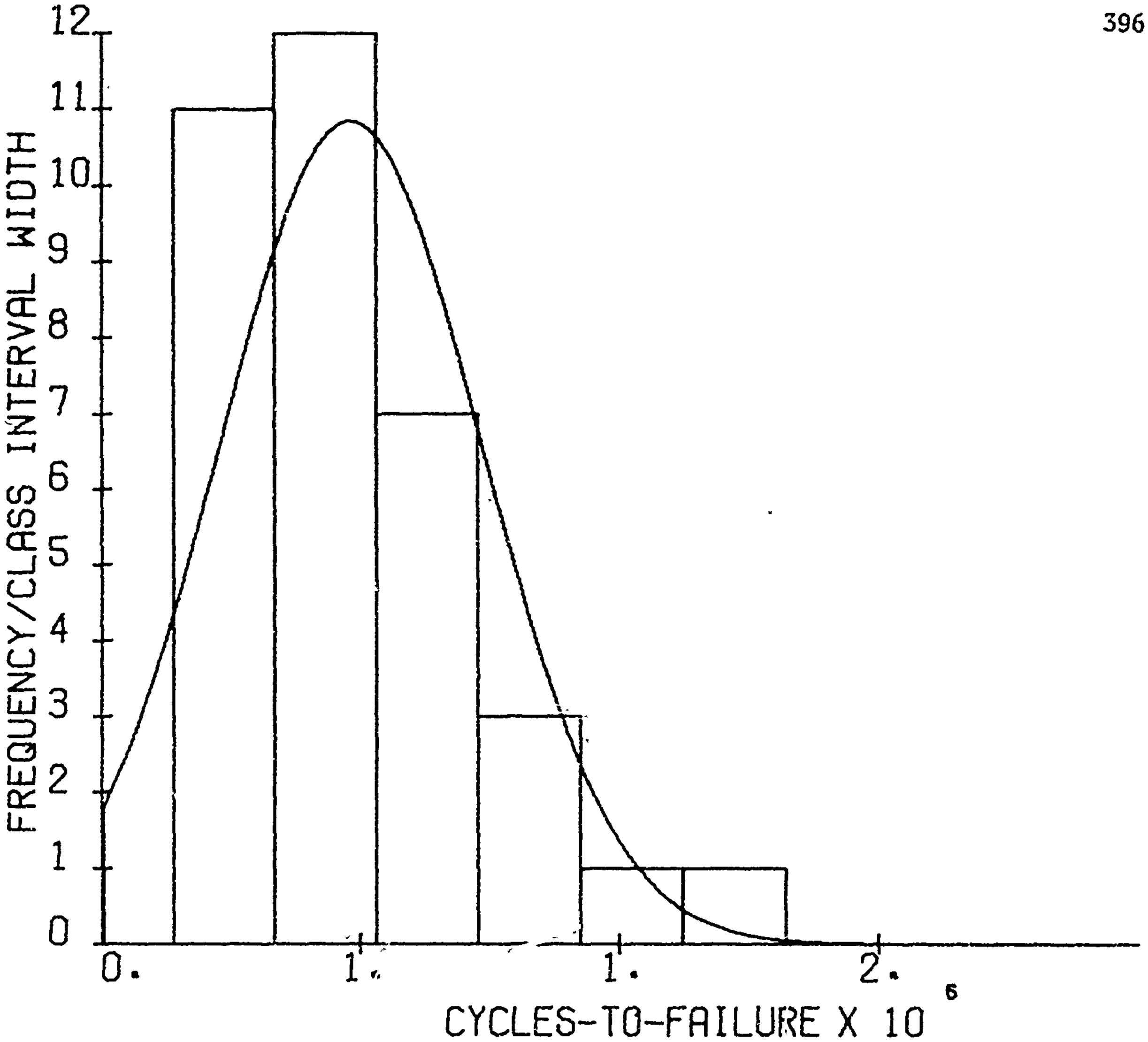
FIG. 9.1-3 CYCLES-TO-FAILURE DIST OF GROUP NO. 129 USING WIRE FATIGUE MACHINE NO. 1 FOR 35 SPECIMENS OF .040 IN. DIAMETER AISI 4130 STEEL WIRE. FIXED ALTERNATING STRESS LEVEL OF 67,700 PSI. BEND ANGLE 19.5 DEGREES. COAST-DOWN CYCLES 100.



KOLMOGOROV-SMIRNOV TEST: 0.078
CHI-SQUARED TEST: 2.127
WEIBULL SLOPE (BETA): 1.725
MINIMUM LIFE (GAMMA): 99000
SCALE PARAMETER (ETA): 751226

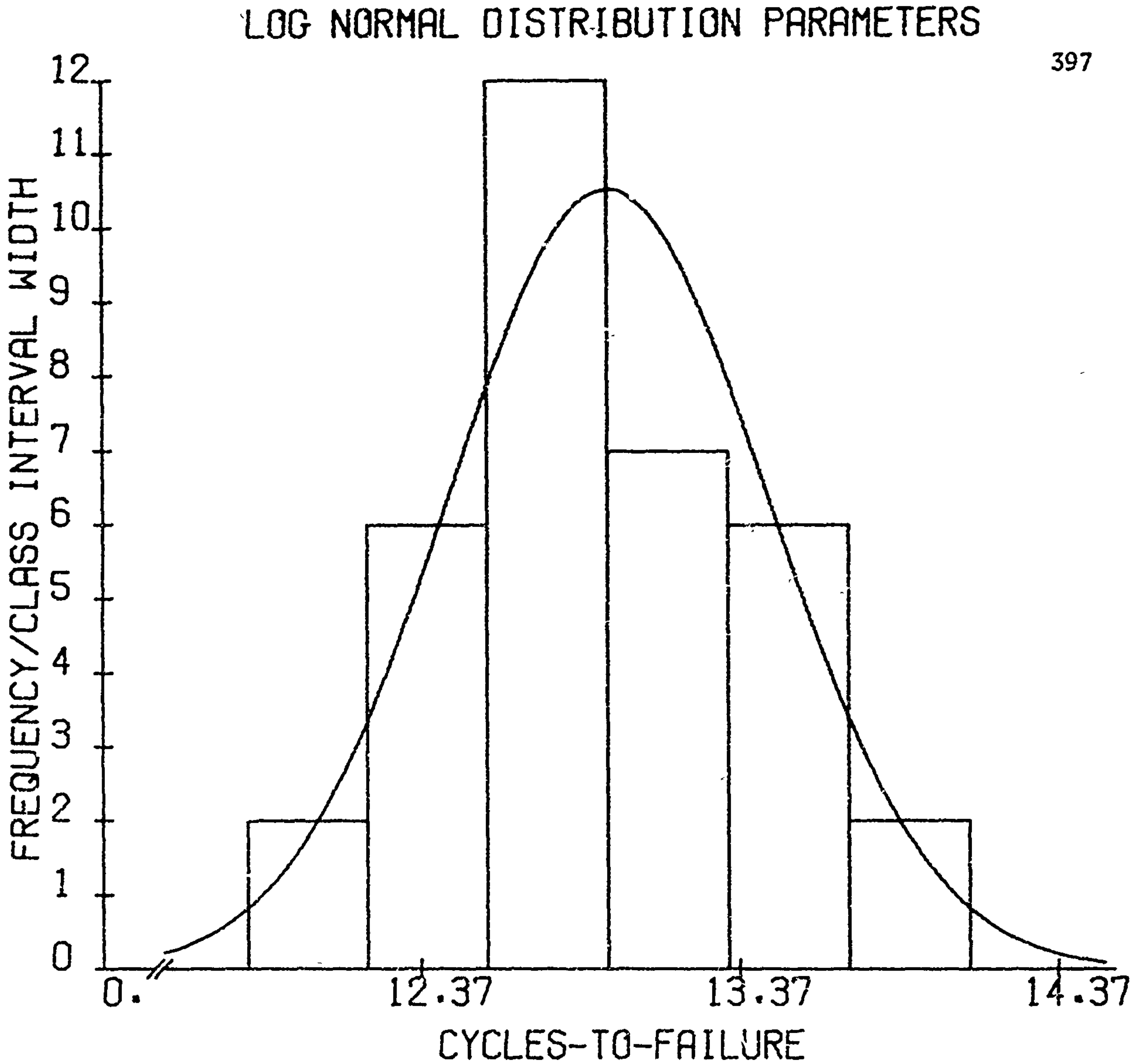
FIG. 9.1-4 CYCLES-TO-FAILURE DISTRIBUTION
SL=67700 PSI
GROUP=129

NORMAL DISTRIBUTION PARAMETERS



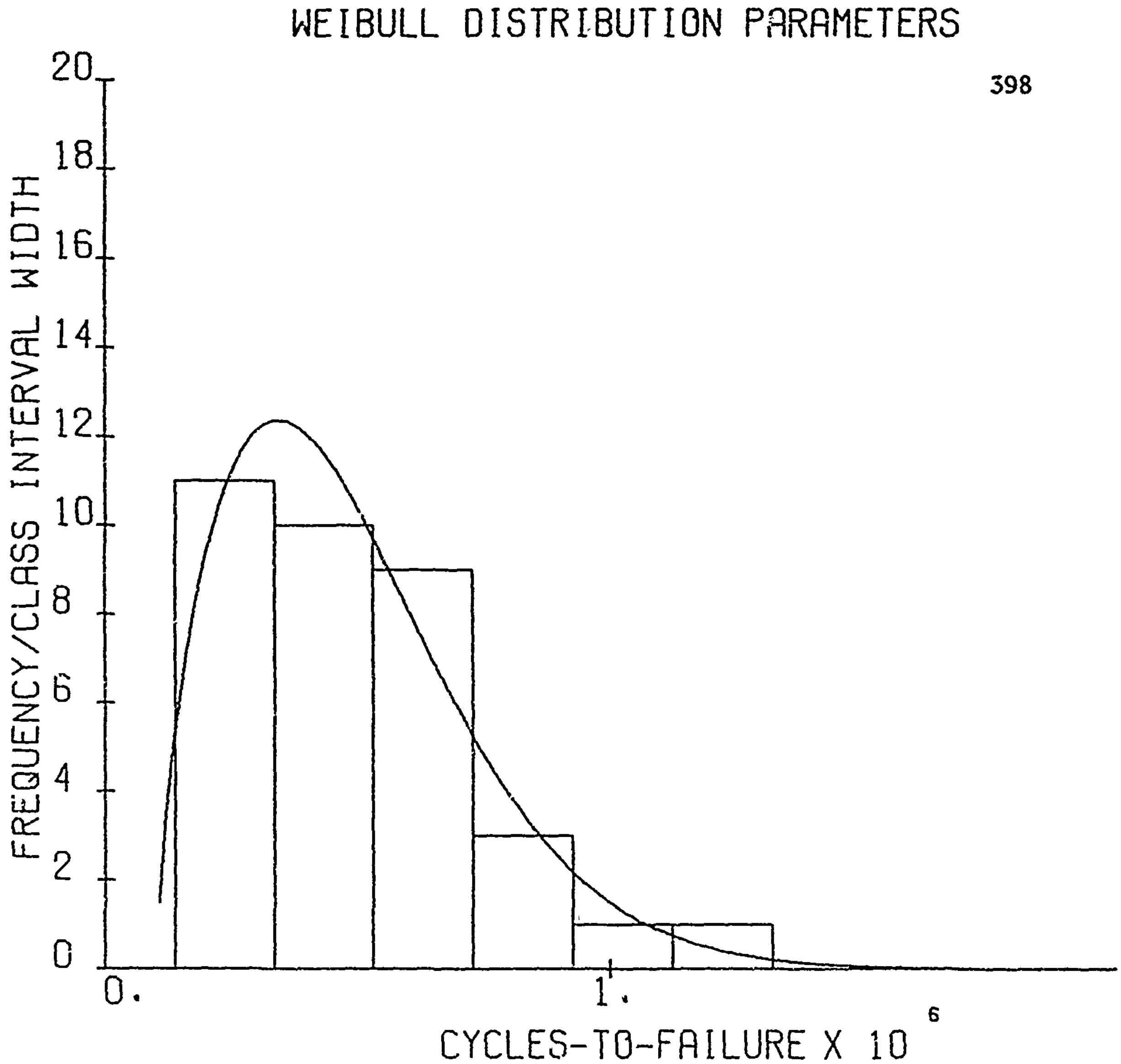
MEAN VALUE:	481634.3 CYCLES
STANDARD DEVIATION:	254057.1 CYCLES
KOLMOGOROV-SMIRNOV TEST:	0.168
CHI-SQUARED TEST:	0.931
SKEWNESS:	1.299
KURTOSIS:	4.752

FIG. 9.1-5 CYCLES-TO-FAILURE DIST OF GROUP NO= 130
USING WISE MACHINE NO. 1 FOR
35 SPECIMENS OF .040 IN. DIAMETER AISI
4130 STEEL WIRE. FIXED ALTERNATING
STRESS LEVEL OF 70,000 PSI. BEND ANGLE
20.0 DEGREES. COAST DOWN CYCLES 200



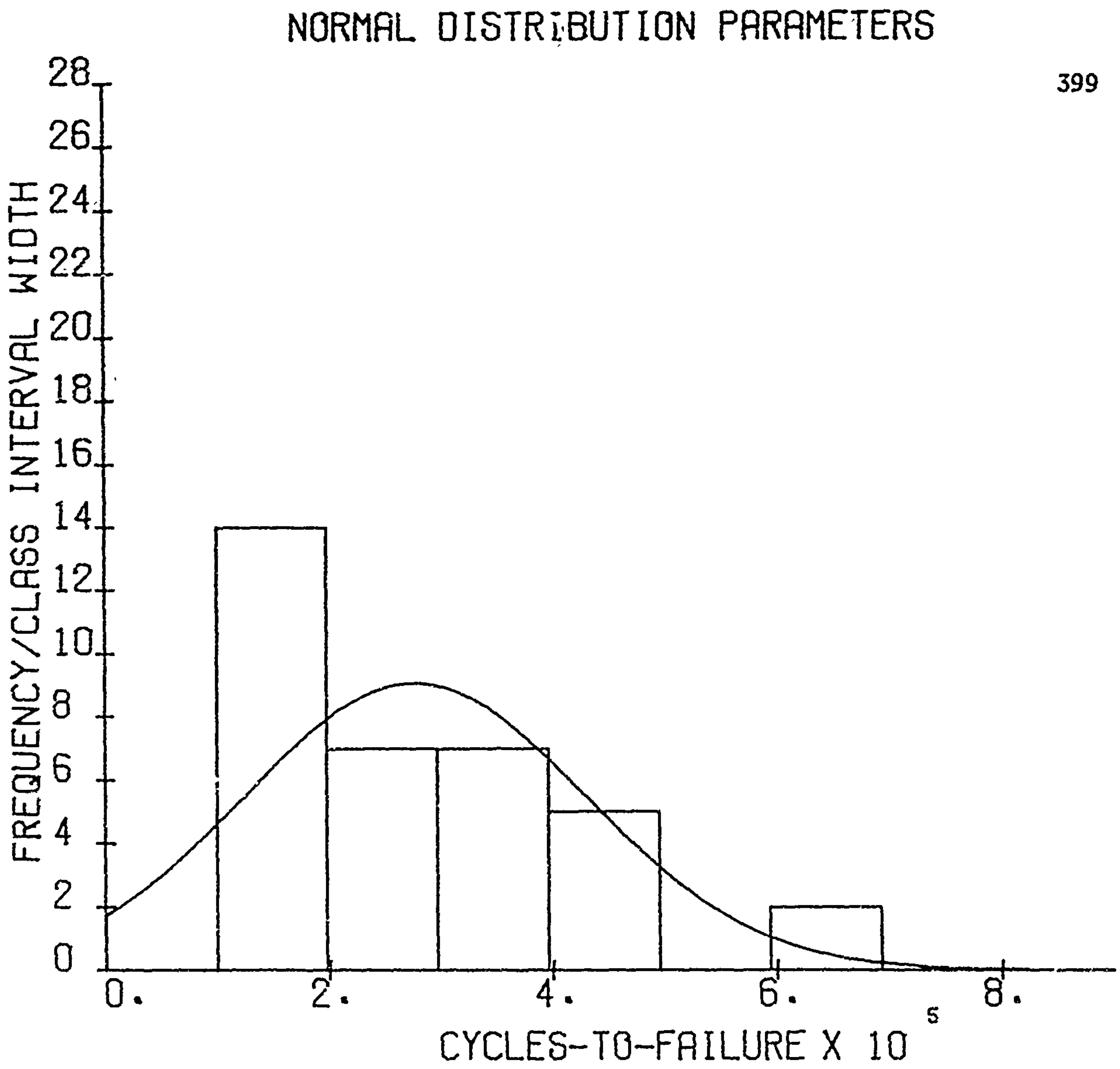
MEAN VALUE: 12.962 CYCLES
STANDARD DEVIATION: 0.502 CYCLES
KOLMOGOROV-SMIRNOV TEST: 0.101
CHI-SQUARED TEST: 1.323
SKEWNESS: 0.065
KURTOSIS: 2.731

FIG. 9.1-6 CYCLES-TO-FAILURE DIST OF GROUP NO= 130 USING WIRE MACHINE NO. 1 FOR 35 SPECIMENS OF .040 IN. DIAMETER AISI 4130 STEEL WIRE. FIXED ALTERNATING STRESS LEVEL OF 70,000 PSI. BEND ANGLE 20.0 DEGREES. COAST DOWN CYCLES 200



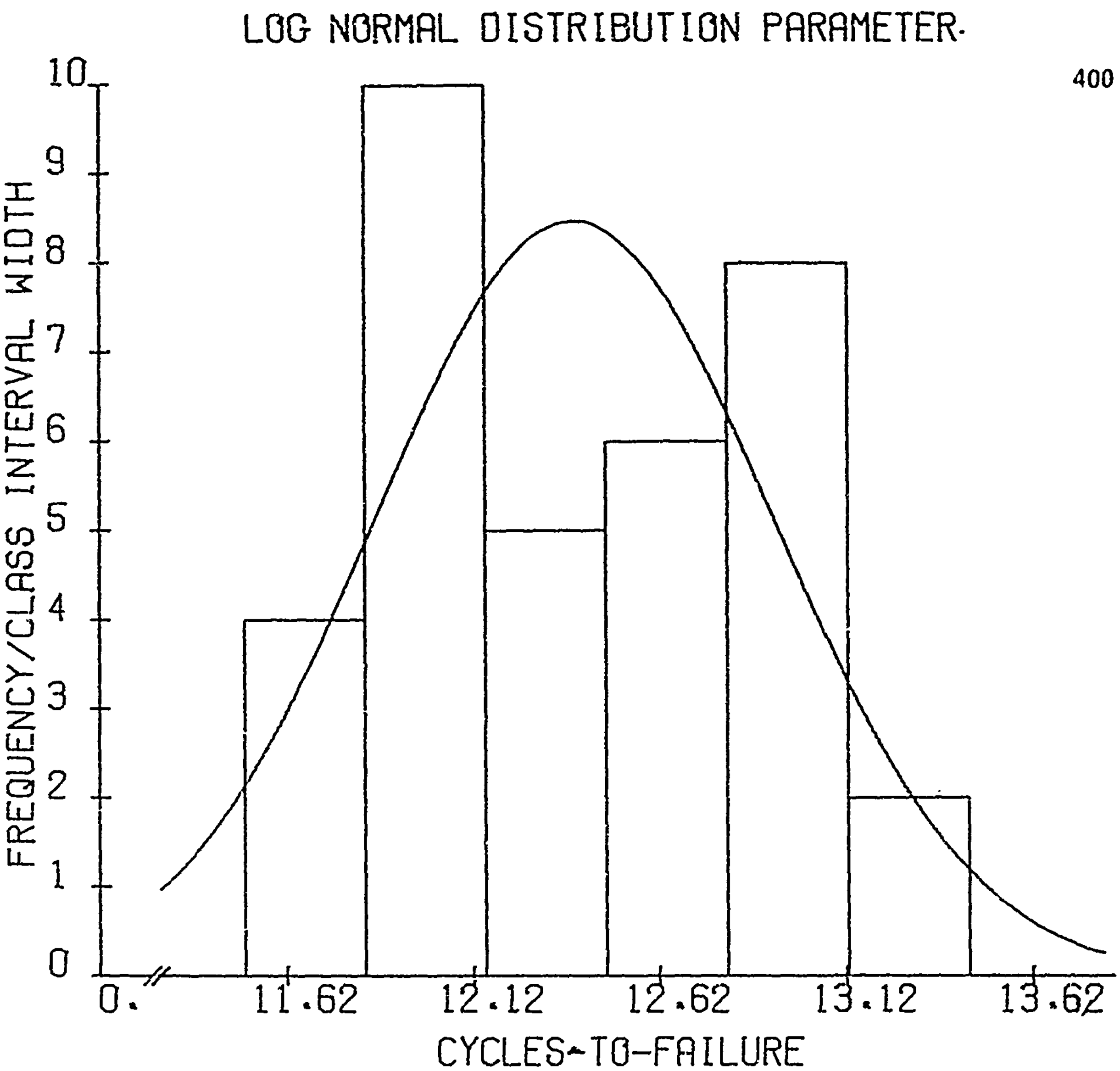
KOLMOGOROV-SMIRNOV TEST: 0.124
CHI-SQUARED TEST: 8.102
WEIBULL SLOPE (BETA): 1.638
MINIMUM LIFE (GAMMA): 101899
SCALE PARAMETER (ETA): 429638

FIG. 9.1-7 CYCLES-TO-FAILURE DISTRIBUTION
GROUP=130
SL=70000 PSI



MEAN VALUE: 276888.6 CYCLES
STANDARD DEVIATION: 152228.3 CYCLES
KOLMOGOROV-SMIRNOV TEST: 0.165
CHI-SQUARED TEST: 1.624
SKEWNESS: 1.025
KURTOSIS: 3.491

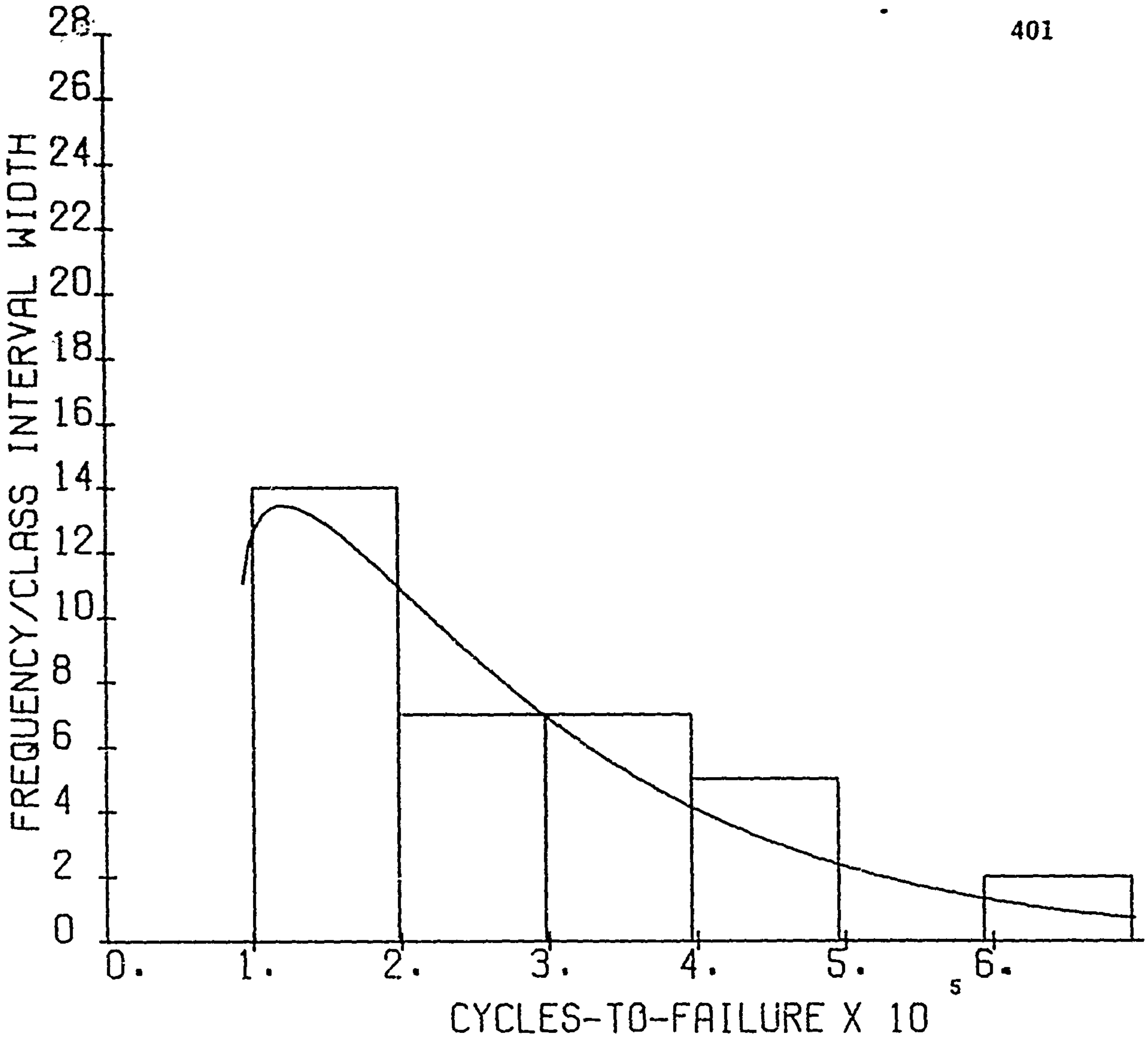
FIG. 9.1-8 CYCLES-TO-FAILURE DIST OF GROUP NO. 131 USING WIRE MACHINE NO. 1 FOR 35 SPECIMENS OF .040 IN. DIAMETER AISI 4130 STEEL WIRE. FIXED ALTERNATING STRESS LEVEL OF 72,500 PSI. BEND ANGLE 20.5 DEGREES. COAST DOWN CYCLES 100.



MEAN VALUE:	12.393 CYCLES
STANDARD DEVIATION:	0.533 CYCLES
KOLMOGOROV-SMIRNOV TEST:	0.096
CHI-SQUARED TEST:	2.801
SKEWNESS:	0.146
KURTOSIS:	2.062

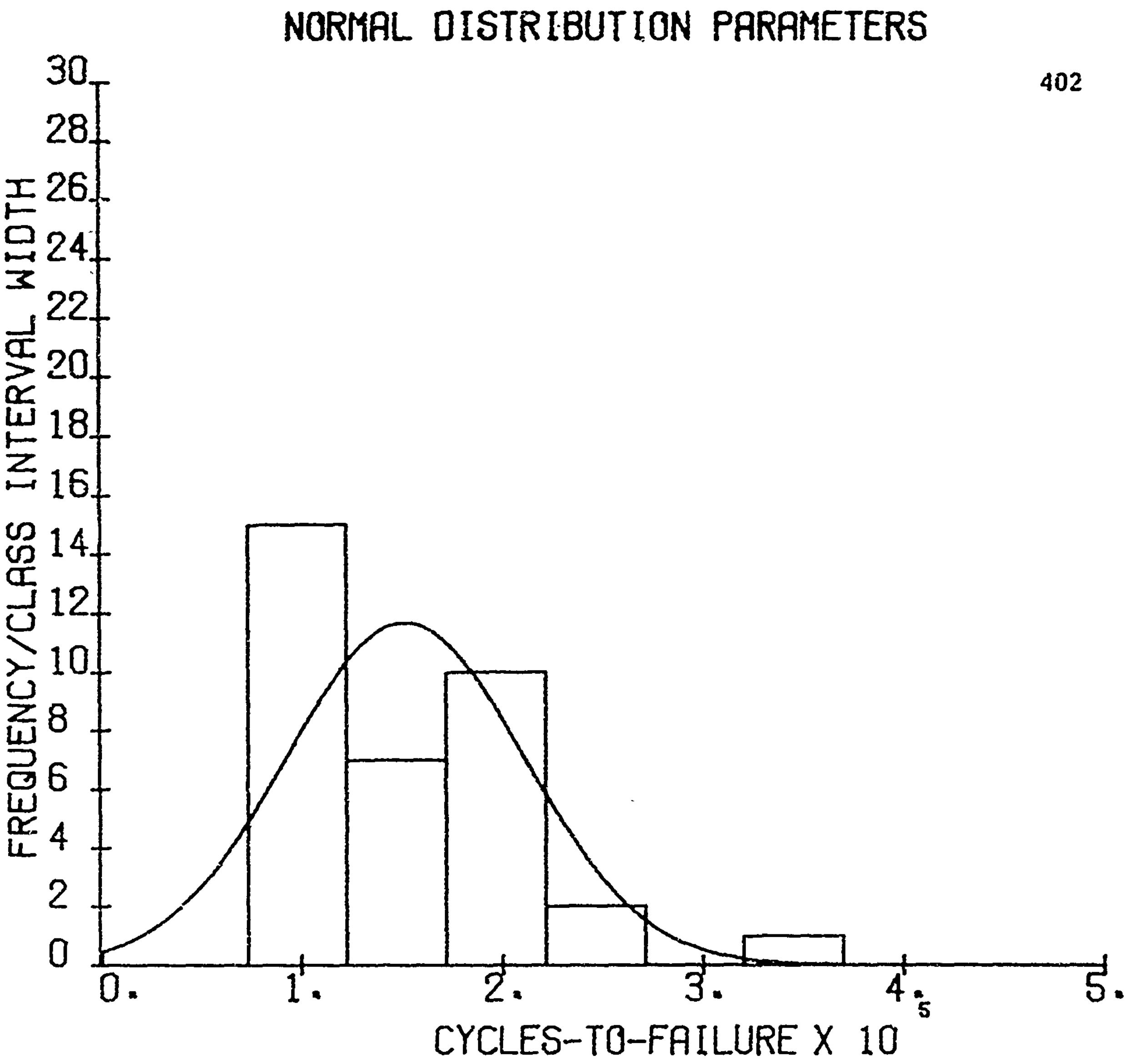
FIG. 9.1-9 CYCLES-TO-FAILURE DIST OF GROUP NO. 131 USING WIRE MACHINE NO. 1 FOR 35 SPECIMENS OF .040 IN. DIAMETER AISI 4130 STEEL WIRE. FIXED ALTERNATING STRESS LEVEL OF 72,500 PSI. BEND ANGLE 20.5 DEGREES. COAST DOWN CYCLES 100.

WEIBULL DISTRIBUTION PARAMETERS



KOLMOGOROV-SMIRNOV TEST: 0.066
CHI-SQUARED TEST: 3.674
WEIBULL SLOPE (BETA): 1.134
MINIMUM LIFE (GAMMA): 90099
SCALE PARAMETER (ETA): 201481

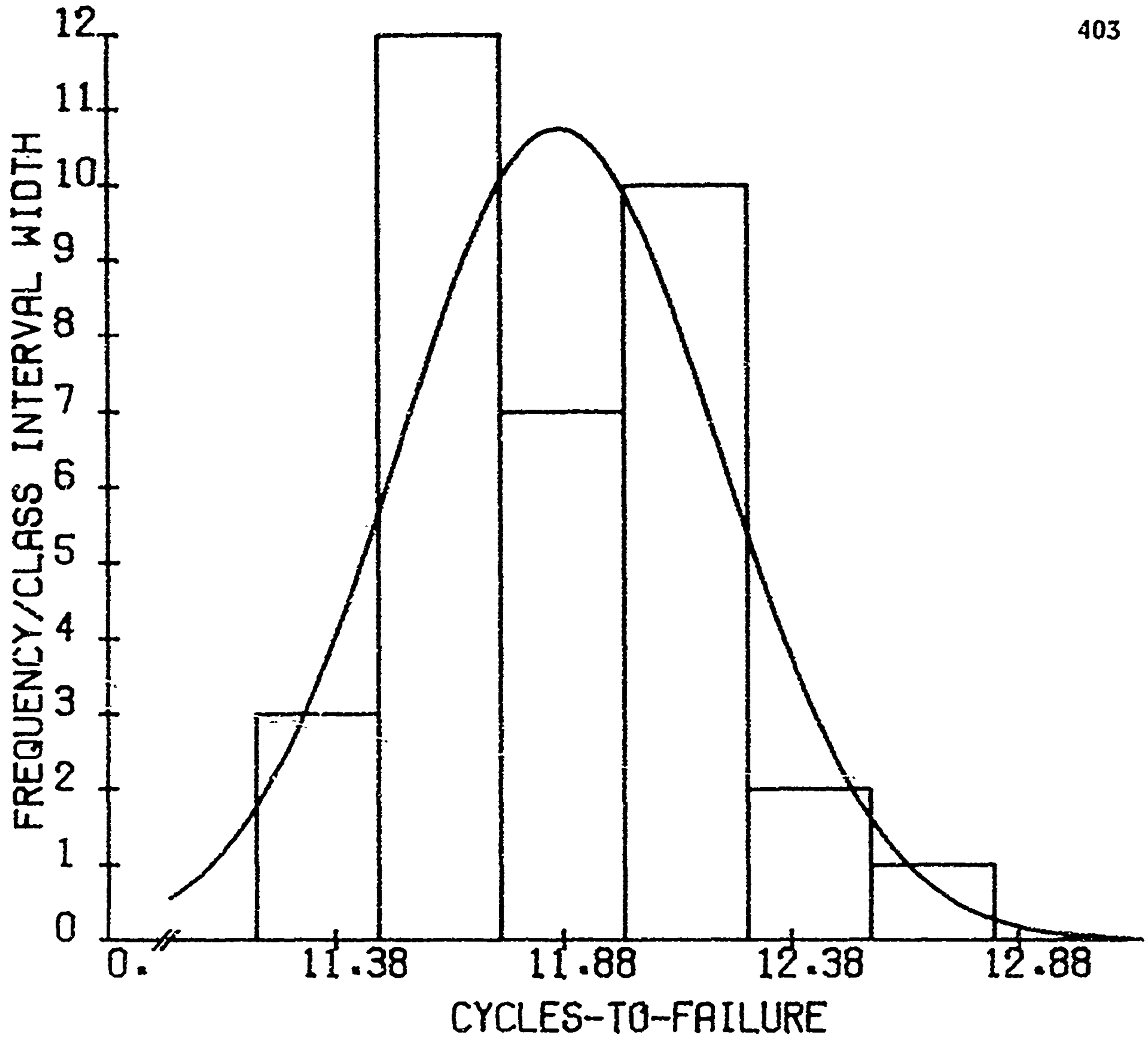
FIG. 9.1-10 CYCLES-TO-FAILURE DISTRIBUTION
GROUP=131
SL=72500 PSI



MEAN VALUE: 151697.1 CYCLES
STANDARD DEVIATION: 59163.8 CYCLES
KOLMOGOROV-SMIRNOV TEST: 0.172
CHI-SQUARED TEST: 3.204
SKEWNESS: 1.526
KURTOSIS: 6.232

FIG. 9.1-11 CYCLES-TO-FAILURE DIST OF GROUP NO= 132 USING WIRE MACHINE NO. 1 FOR 35 SPECIMENS OF .040 IN. DIAMETER AISI 4130 STEEL WIRE. FIXED ALTERNATING STRESS LEVEL OF 74,700 PSI. BEND ANGLE 21.0 DEGREES. COAST DOWN CYCLES 200

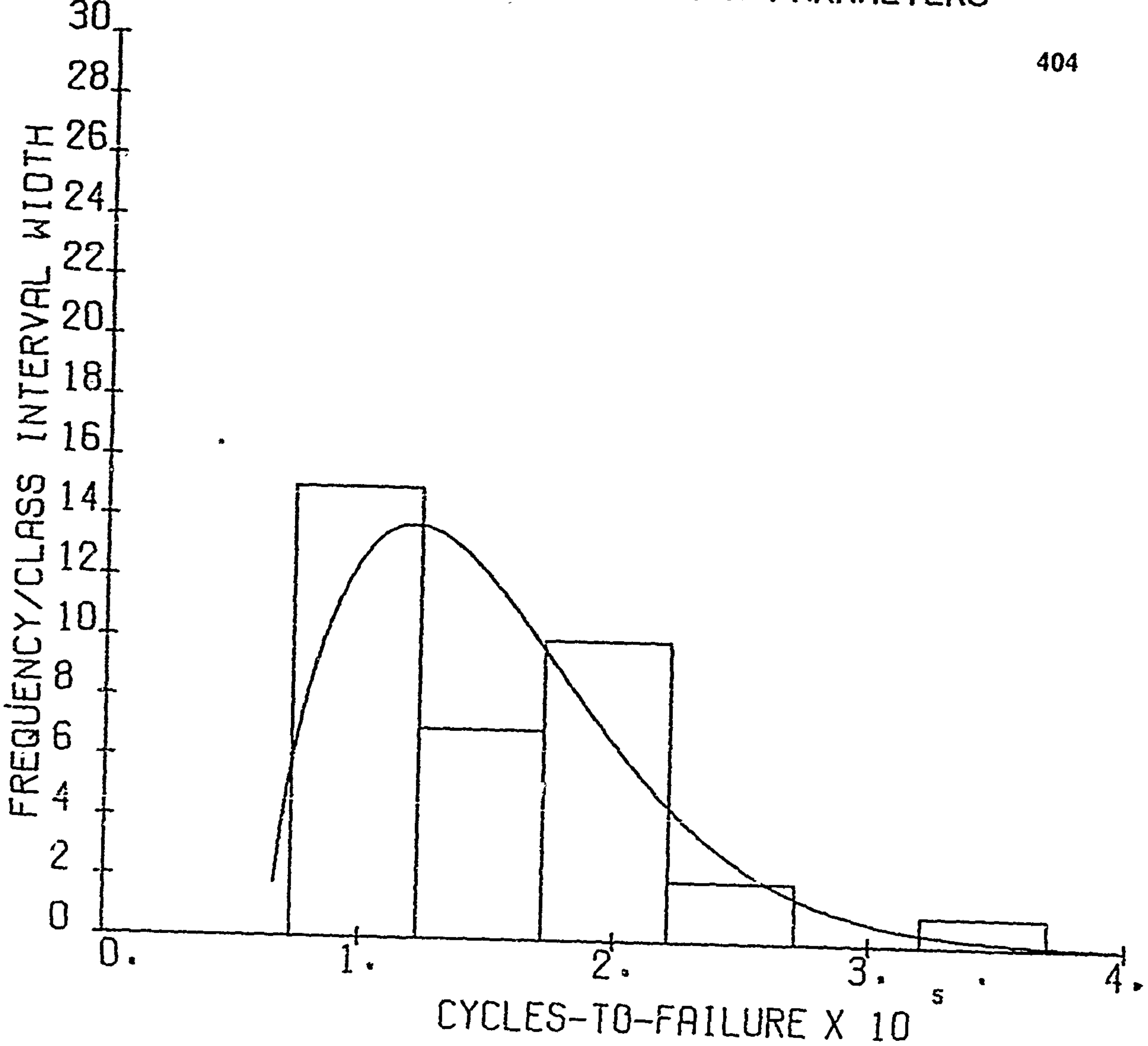
LOG NORMAL DISTRIBUTION PARAMETERS



MEAN VALUE:	11.867	CYCLES
STANDARD DEVIATION:	0.351	CYCLES
KOLMOGOROV-SMIRNOV TEST:	0.112	
CHI-SQUARED TEST:	1.725	
SKEWNESS:	0.496	
KURTOSIS:	2.861	

FIG. 9.1-12 CYCLES-TO-FAILURE DIST OF GROUP NO= 132 USING WIRE MACHINE NO. 1 FOR 35 SPECIMENS OF .040 IN. DIAMETER AISI 4130 STEEL WIRE. FIXED ALTERNATING STRESS LEVEL OF 74,700 PSI. BEND ANGLE 21.0 DEGREES. COAST DOWN CYCLES 200

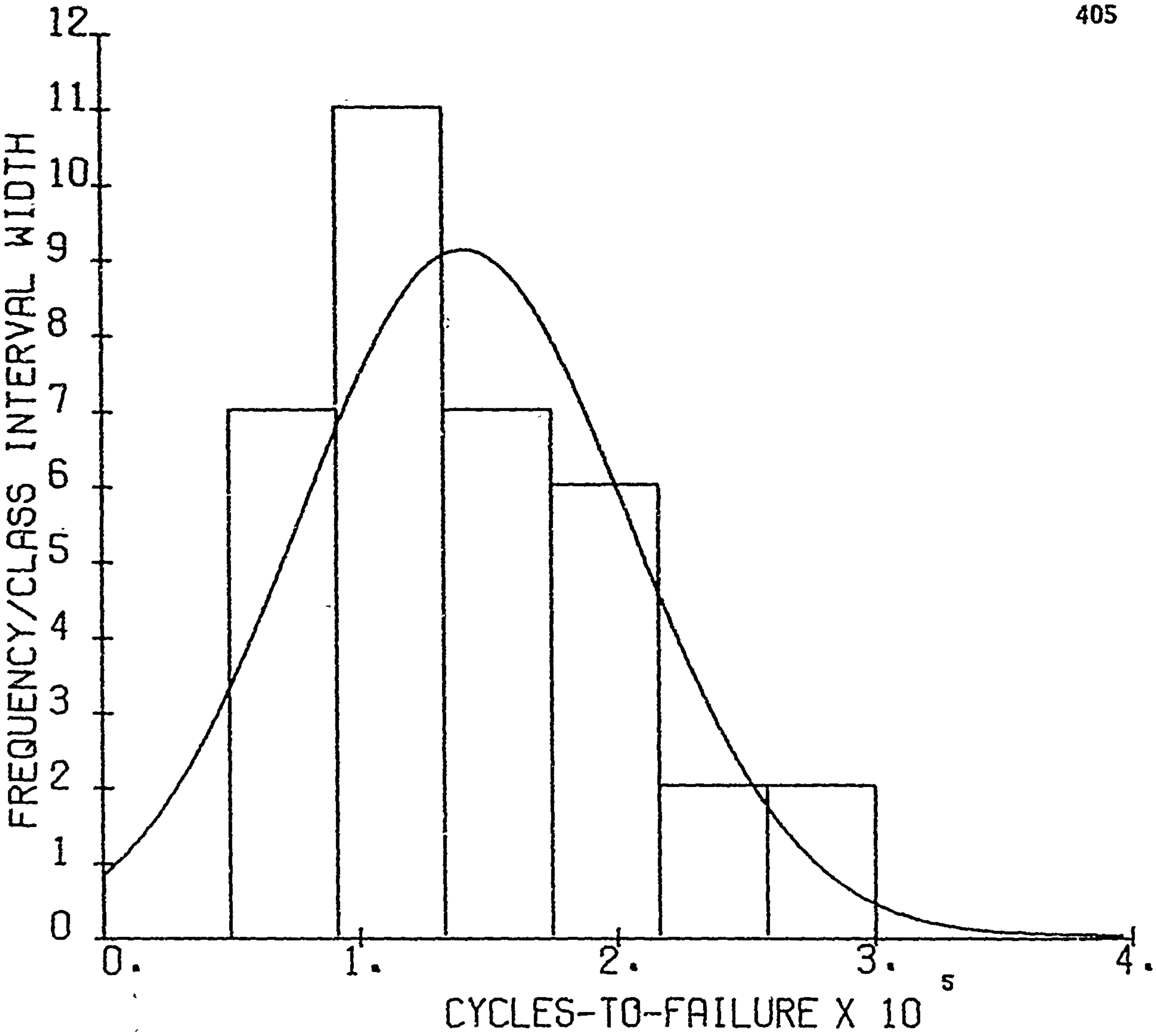
WEIBULL DISTRIBUTION PARAMETERS



KOLMOGOROV-SMIRNOV TEST: 0.114
CHI-SQUARED TEST: 4.097
WEIBULL SLOPE (BETA): 1.642
MINIMUM LIFE (GAMMA): 65399
SCALE PARAMETER (ETA): 96714

FIG. 9.1-13 CYCLES-TO-FAILURE DISTRIBUTION
GROUP=132
SL=74700 PSI

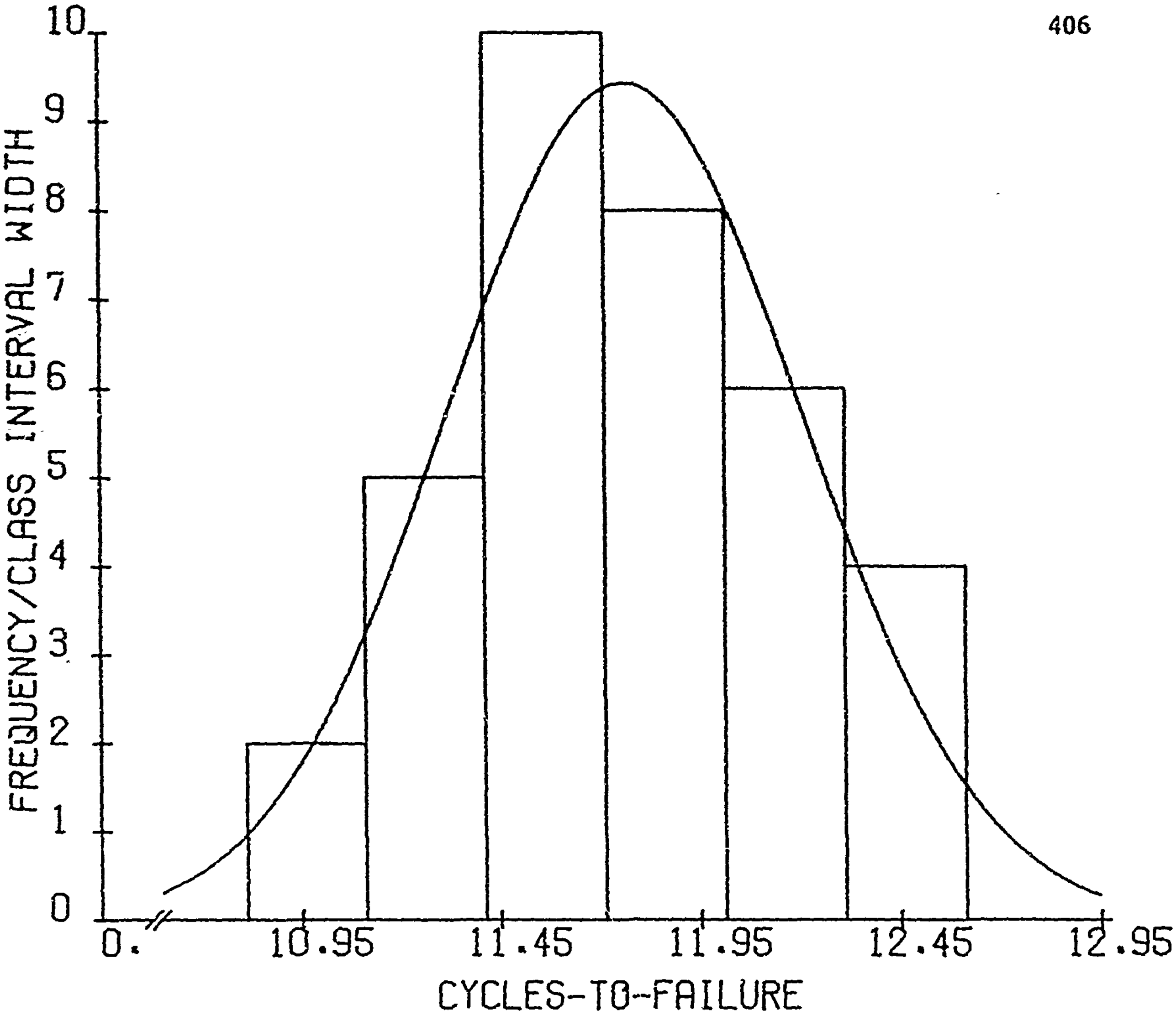
NORMAL DISTRIBUTION PARAMETERS



MEAN VALUE:	141077.1	CYCLES
STANDARD DEVIATION:	64047.8	CYCLES
KOLMOGOROV-SMIRNOV TEST:	0.171	
CHI-SQUARED TEST:	1.462	
SKEWNESS:	0.905	
KURTOSIS:	3.091	

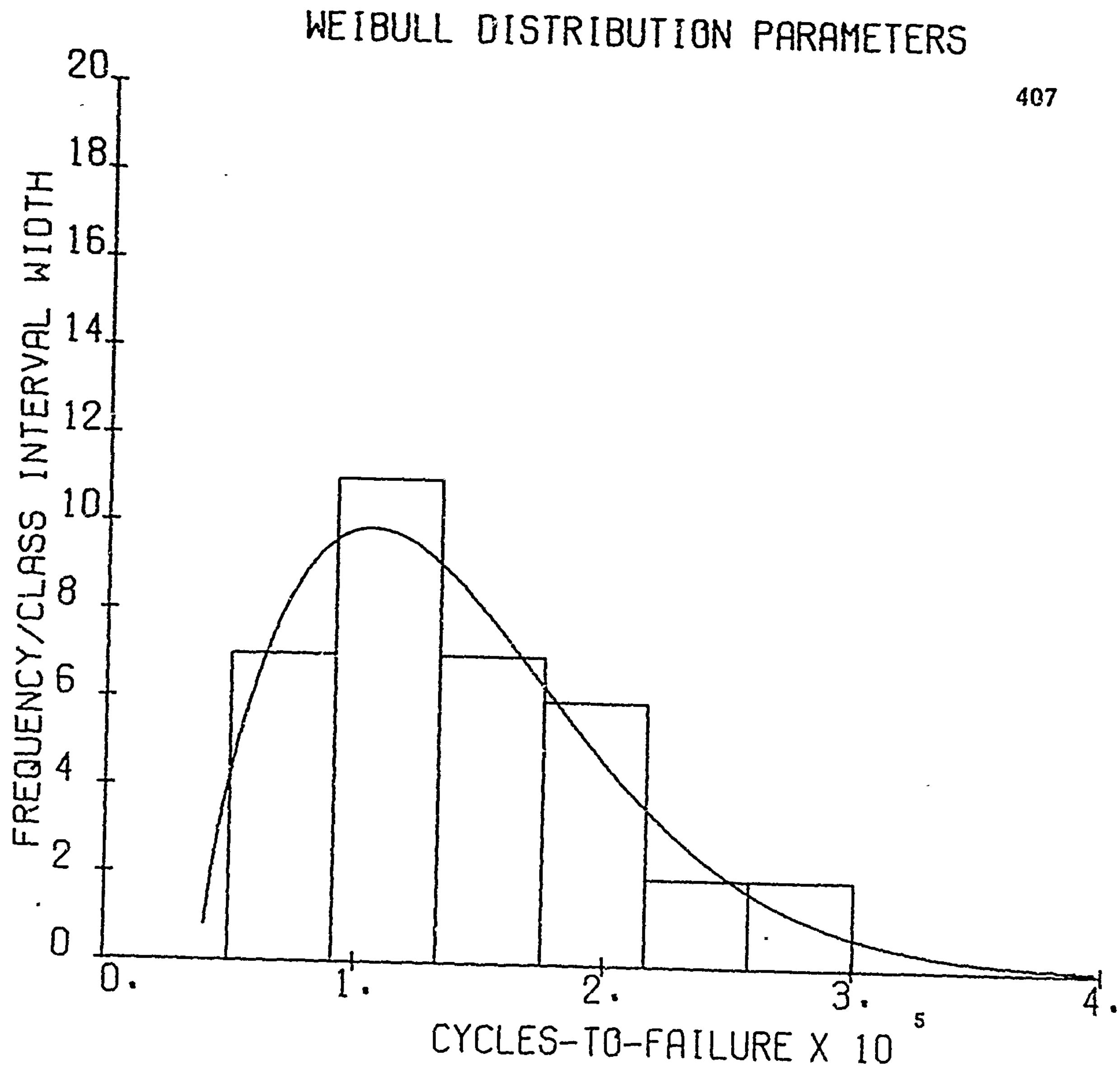
FIG. 9.1-14 CYCLES-TO-FAILURE DIST OF GROUP NO= 133
USING WIRE MACHINE NO. 1 FOR
35 SPECIMENS OF .040 IN. DIAMETER AISI
4130 STEEL WIRE. FIXED ALTERNATING
STRESS LEVEL OF 77,800 PSI. BEND ANGLE
21.5 DEGREES. COAST DOWN CYCLES 200

LOG NORMAL DISTRIBUTION PARAMETERS



MEAN VALUE:	11.761	CYCLES
STANDARD DEVIATION:	0.445	CYCLES
KOLMOGOROV-SMIRNOV TEST:	0.086	
CHI-SQUARED TEST:	0.464	
SKEWNESS:	0.029	
KURTOSIS:	2.497	

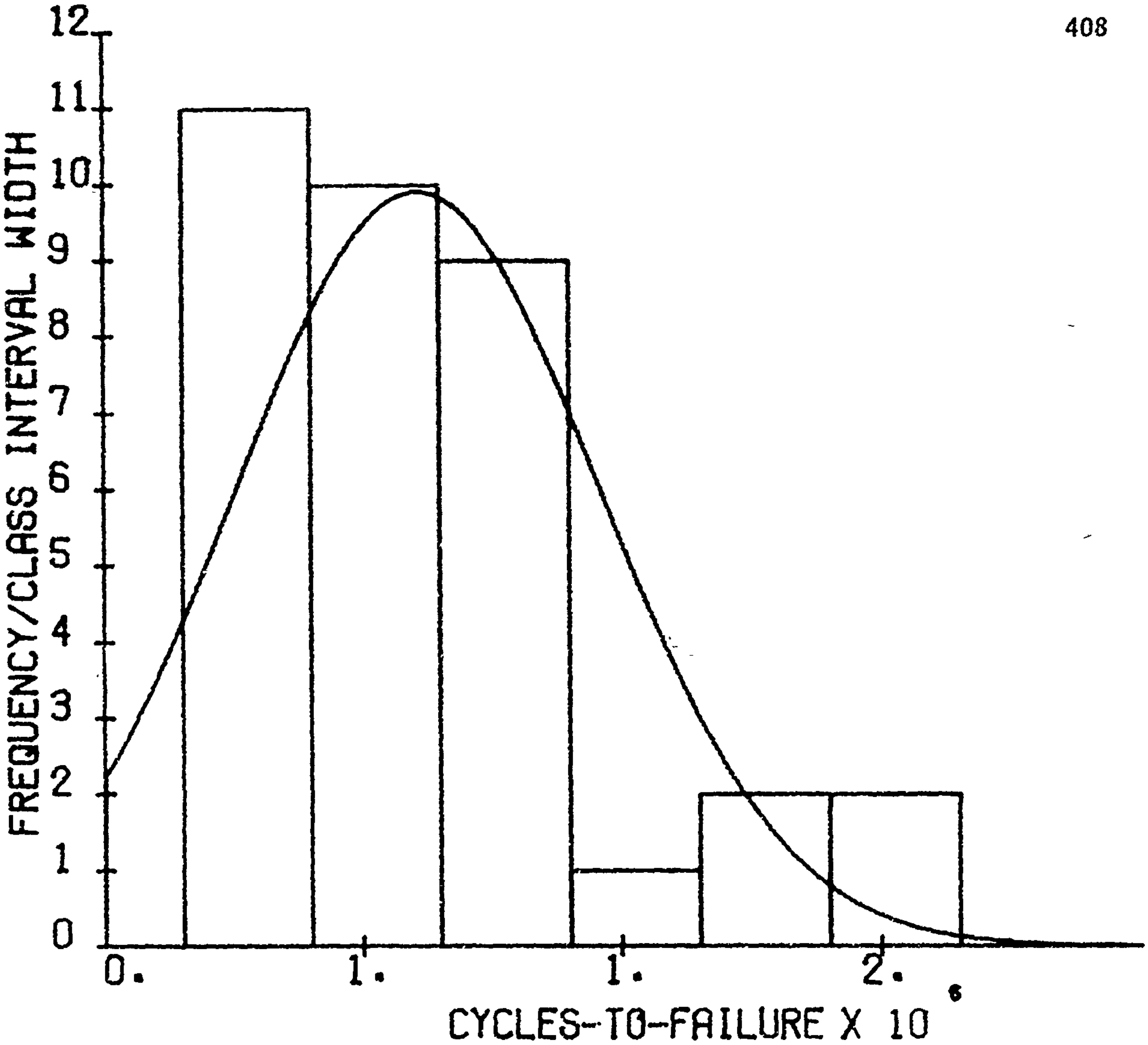
FIG. 9.1-15 CYCLES-TO-FAILURE DIST OF GROUP NO= 133 USING WIRE MACHINE NO. 1 FOR 35 SPECIMENS OF .040 IN. DIAMETER AISI 4130 STEEL WIRE. FIXED ALTERNATING STRESS LEVEL OF 77,800 PSI. BEND ANGLE 21.5 DEGREES. COAST DOWN CYCLES 200



KOLMOGOROV-SMIRNOV TEST: 0.112
CHI-SQUARED TEST: 3.390
WEIBULL SLOPE (BETA): 1.670
MINIMUM LIFE (GAMMA): 39099
SCALE PARAMETER (ETA): 114833

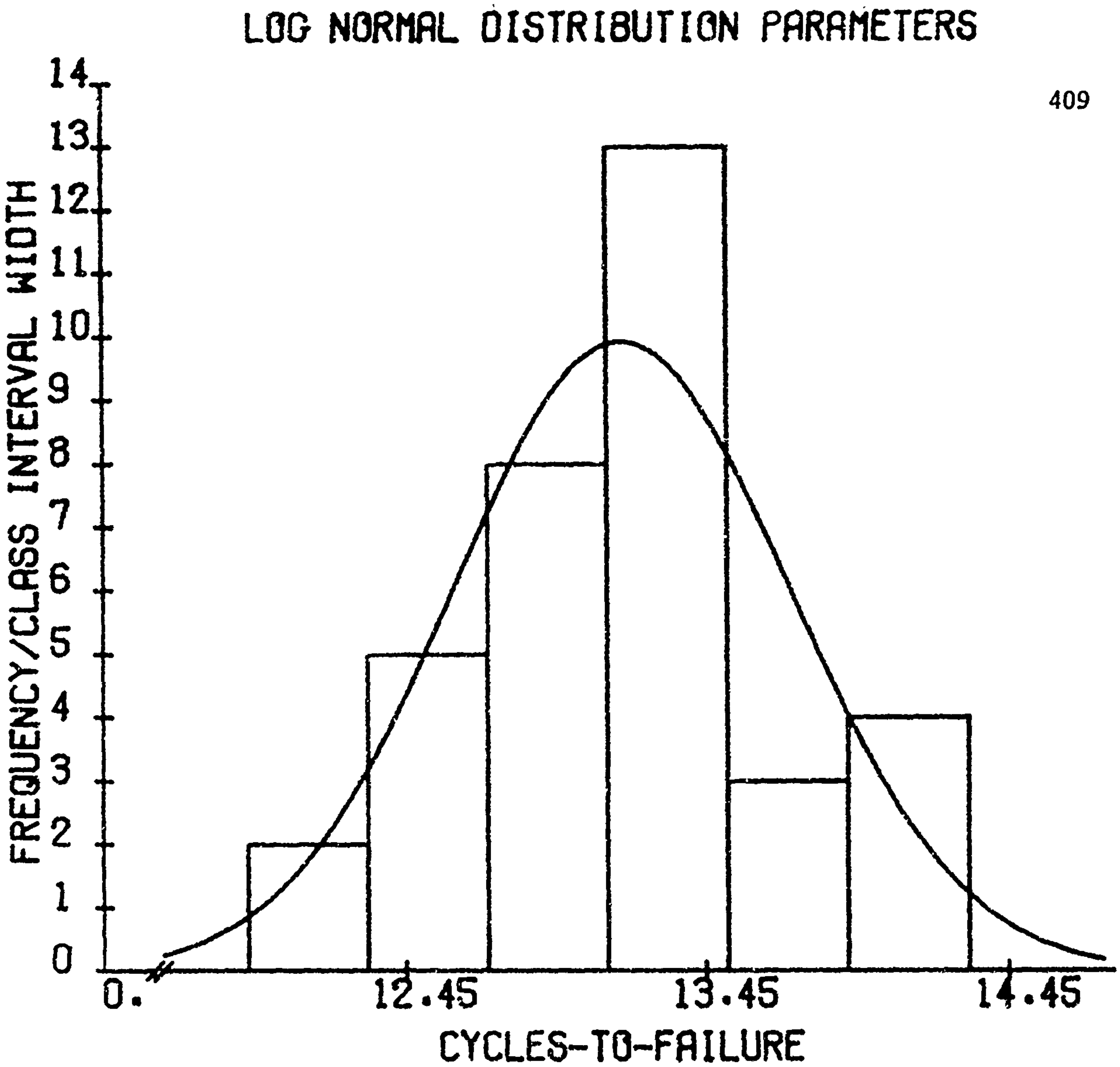
FIG. 9.1-16 CYCLES-TO-FAILURE DISTRIBUTION
GROUP=133
SL=77800 PSI

NORMAL DISTRIBUTION PARAMETERS



MEAN VALUE:	608431.4	CYCLES
STANDARD DEVIATION:	352142.8	CYCLES
KOLMOGOROV-SMIRNOV TEST:	0.165	
CHI-SQUARED TEST:	0.828	
SKEWNESS:	1.284	
KURTOSIS:	4.315	

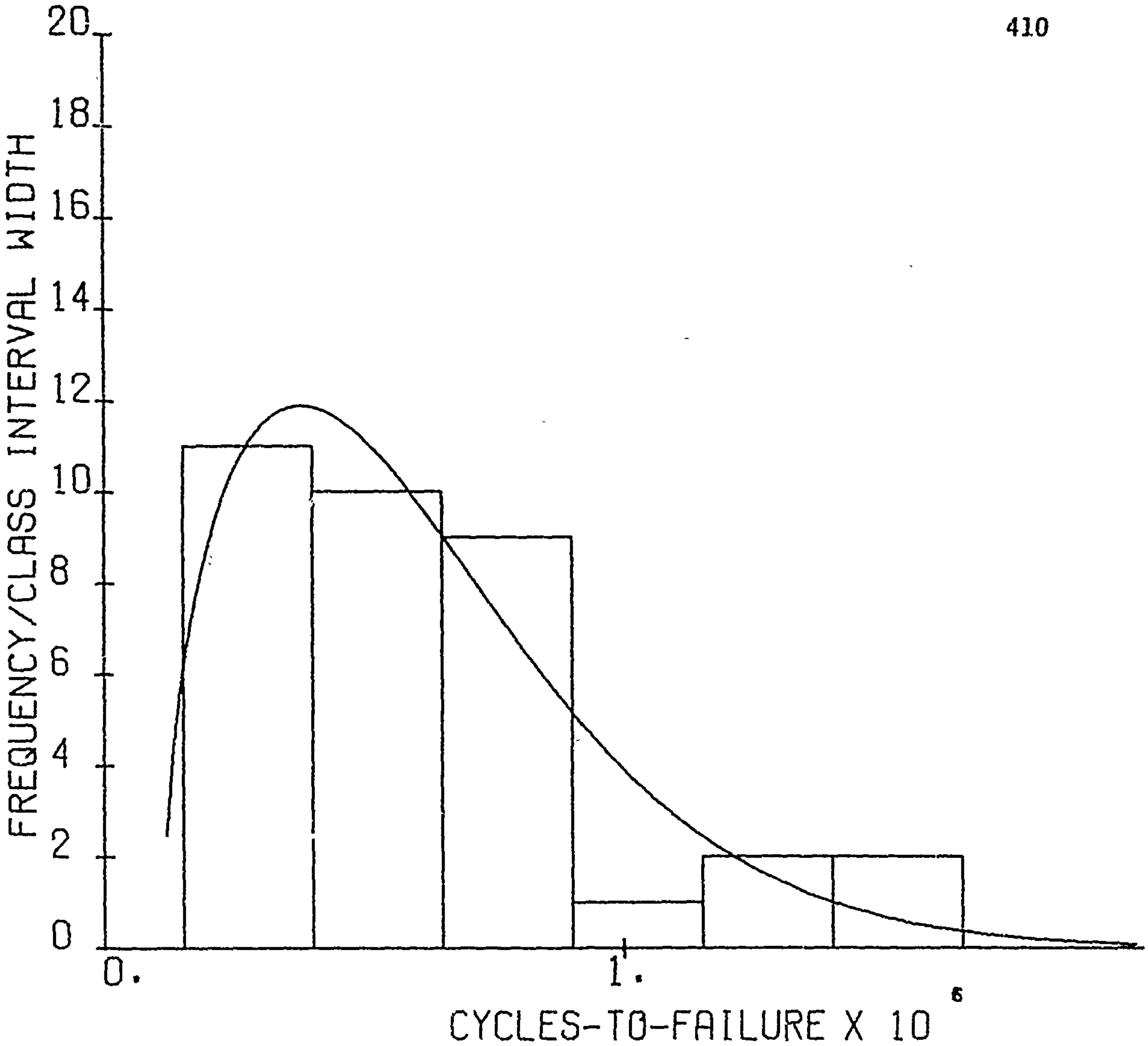
FIG. 9.1-17 CYCLES-TO-FAILURE DIST. OF GROUP NO. 136 USING WIRE FATIGUE MACHINE NO. 2 FOR 35 SPECIMENS OF .040 IN. DIAMETER AISI 1038 STEEL WIRE. FIXED ALTERNATING STRESS LEVEL OF 64,500 PSI. BEND ANGLE 17.0 DEGREES. COAST-DOWN CYCLES 100.



MEAN VALUE:	13.168 CYCLES
STANDARD DEVIATION:	0.561 CYCLES
KOLMOGOROV-SMIRNOV TEST:	0.074
CHI-SQUARED TEST:	2.072
SKEWNESS:	-0.042
KURTOSIS:	2.704

FIG. 9-1-18 CYCLES-TO-FAILURE DIST. OF GROUP NO. 136 USING WIRE FATIGUE MACHINE NO. 2 FOR 35 SPECIMENS OF .040 IN. DIAMETER AISI 1038 STEEL WIRE. FIXED ALTERNATING STRESS LEVEL OF 64,500 PSI. BEND ANGLE 17.0 DEGREES. COAST-DOWN CYCLES 100.

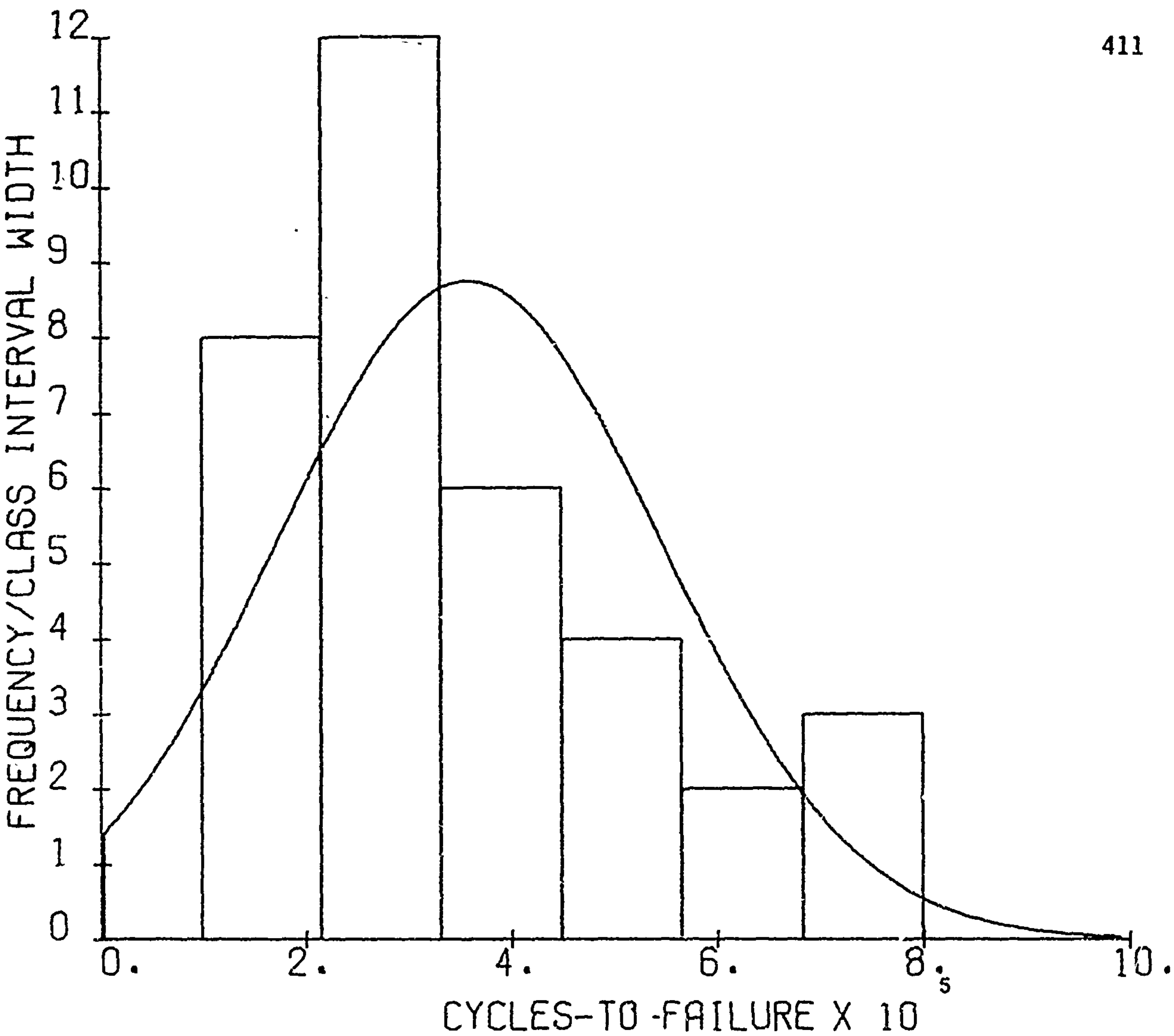
WEIBULL DISTRIBUTION PARAMETERS



KOLMOGOROV-SMIRNOV TEST: 0.102
CHI-SQUARED TEST: 3.708
WEIBULL SLOPE (BETA): 1.509
MINIMUM LIFE (GAMMA): 113600
SCALE PARAMETER (ETA): 549476

FIG. 9.1-19 CYCLES-TO-FAILURE DISTRIBUTION
SL=64500 PSI
GROUP=136

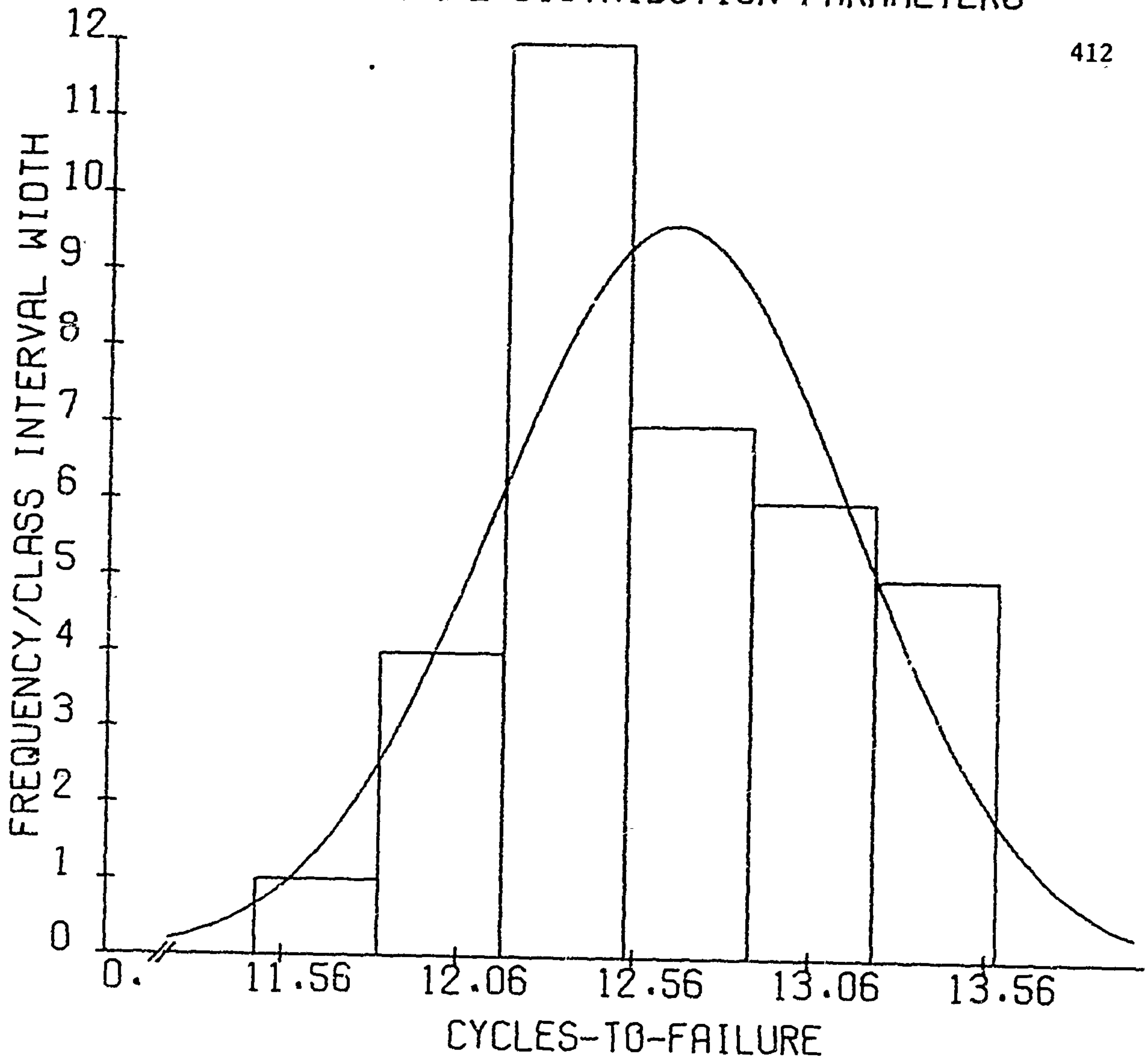
NORMAL DISTRIBUTION PARAMETERS



MEAN VALUE: 357925.7 CYCLES
STANDARD DEVIATION: 186783.7 CYCLES
KOLMOGOROV-SMIRNOV TEST: 0.168
CHI-SQUARED TEST: 3.907
SKEWNESS: 0.980
KURTOSIS: 3.137

FIG. 9.1-20 CYCLES-TO-FAILURE DIST OF GROUP NO. 137 USING WIRE MACHINE NO. 2 FOR 35 SPECIMENS OF .040 IN. DIAMETER AISI 1038 STEEL WIRE. FIXED ALTERNATING STRESS LEVEL OF 67,200 PSI. BEND ANGLE 17.5 DEGREES. COAST DOWN CYCLES 100.

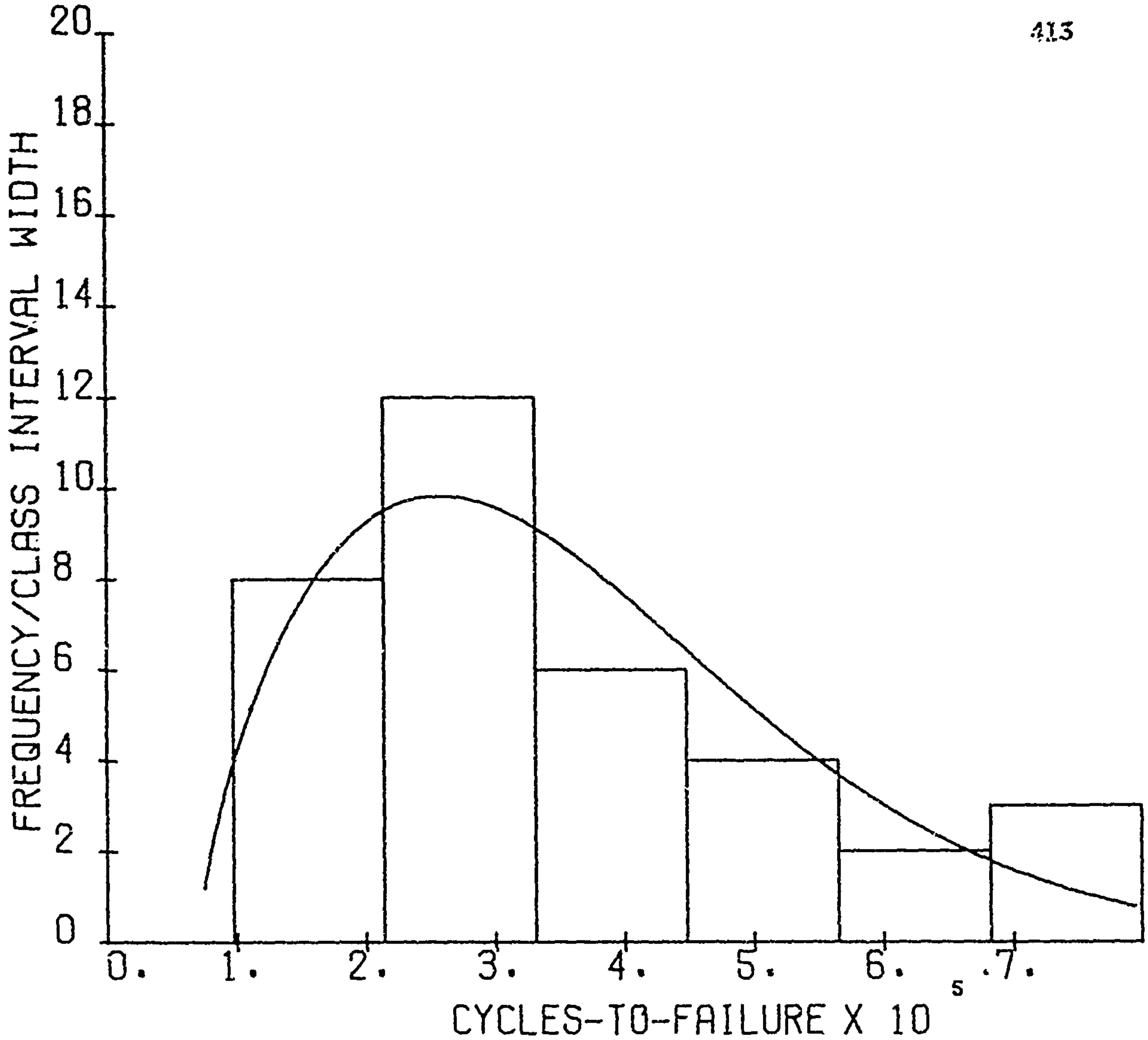
LOG NORMAL DISTRIBUTION PARAMETERS



MEAN VALUE:	12.663	CYCLES
STANDARD DEVIATION:	0.510	CYCLES
KOLMOGOROV-SMIRNOV TEST:	0.109	
CHI-SQUARED TEST:	3.034	
SKEWNESS:	0.041	
KURTOSIS:	2.497	

FIG. 9.1-21 CYCLES-TO-FAILURE DIST OF GROUP NO. 137 USING WIRE MACHINE NO. 2 FOR 35 SPECIMENS OF .040 IN. DIAMETER AISI 1038 STEEL WIRE. FIXED ALTERNATING STRESS LEVEL OF 67,200 PSI. BEND ANGLE 17.5 DEGREES. COAST DOWN CYCLES 100.

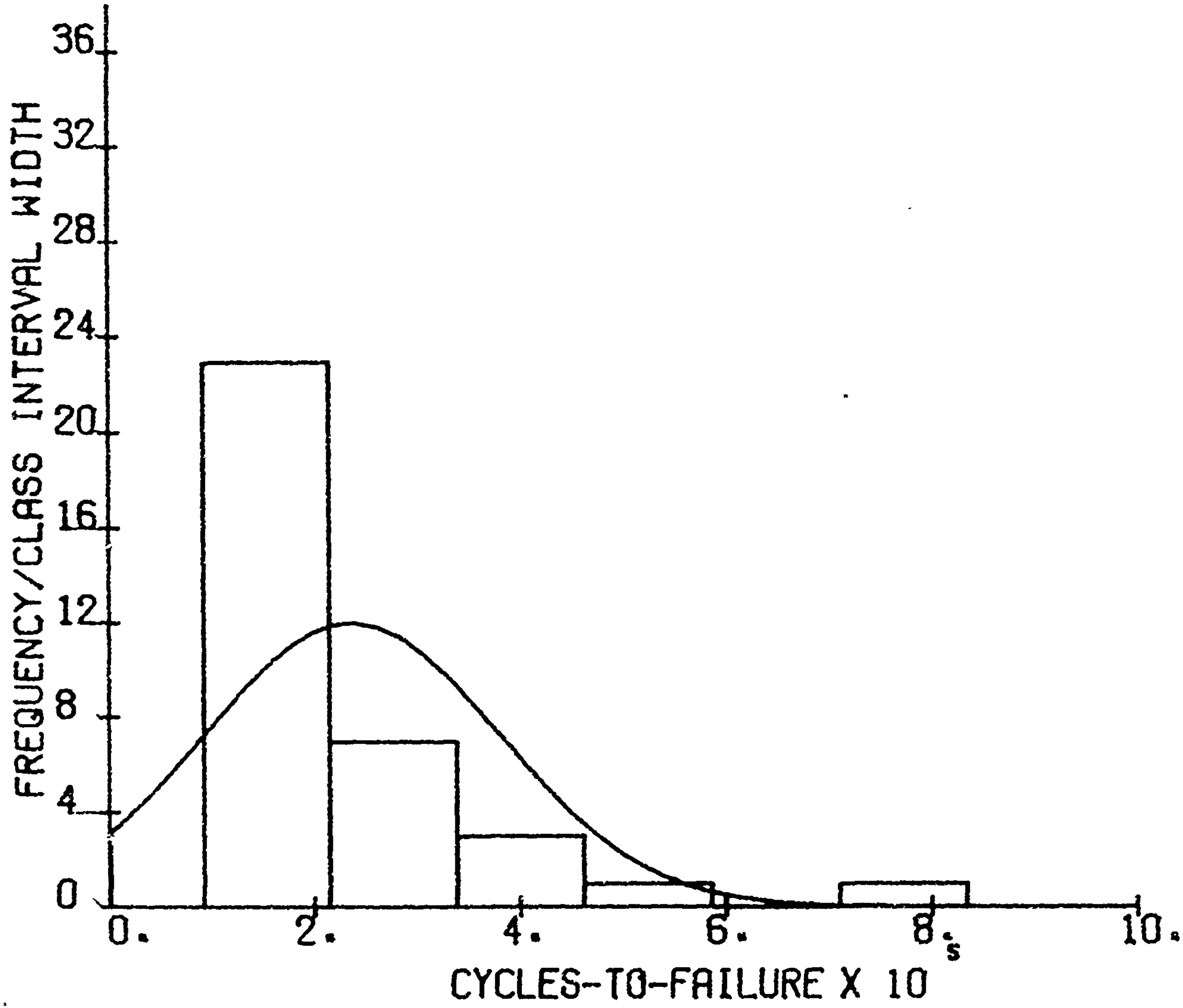
WEIBULL DISTRIBUTION PARAMETERS



KOLMOGOROV-SMIRNOV TEST: 0.127
CHI-SQUARED TEST: 4.044
WEIBULL SLOPE (BETA): 1.674
MINIMUM LIFE (GAMMA): 70099
SCALE PARAMETER (ETA): 323481

FIG. 9.1-22 CYCLES-TO-FAILURE DISTRIBUTION
GROUP=137
SL=67200 PSI

NORMAL DISTRIBUTION PARAMETERS



MEAN VALUE: 236162.9 CYCLES

STANDARD DEVIATION: 144220.2 CYCLES

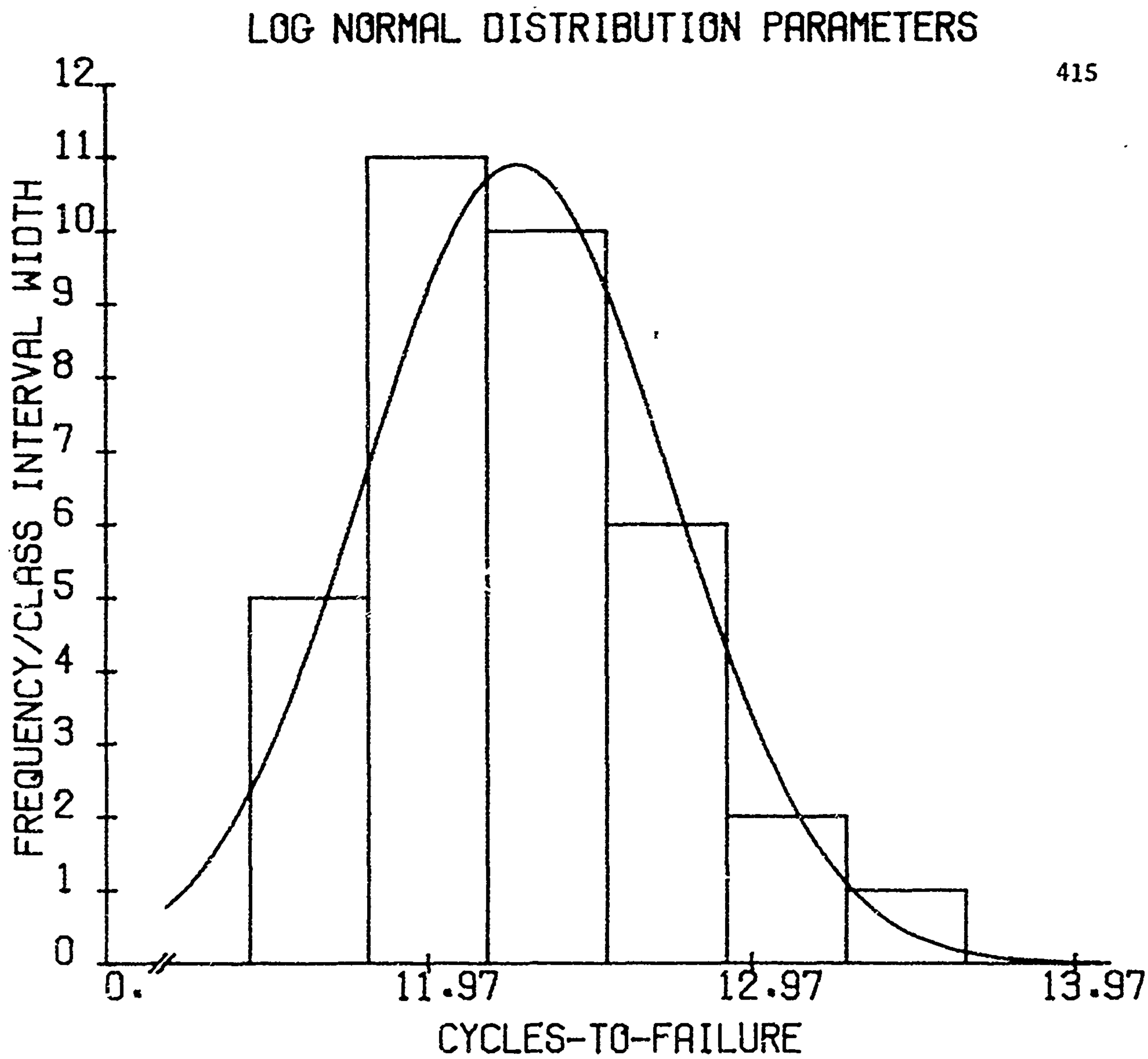
KOLMOGOROV-SMIRNOV TEST: 0.255

CHI-SQUARED TEST: 6.637

SKEWNESS: 2.460

KURTOSIS: 10.014

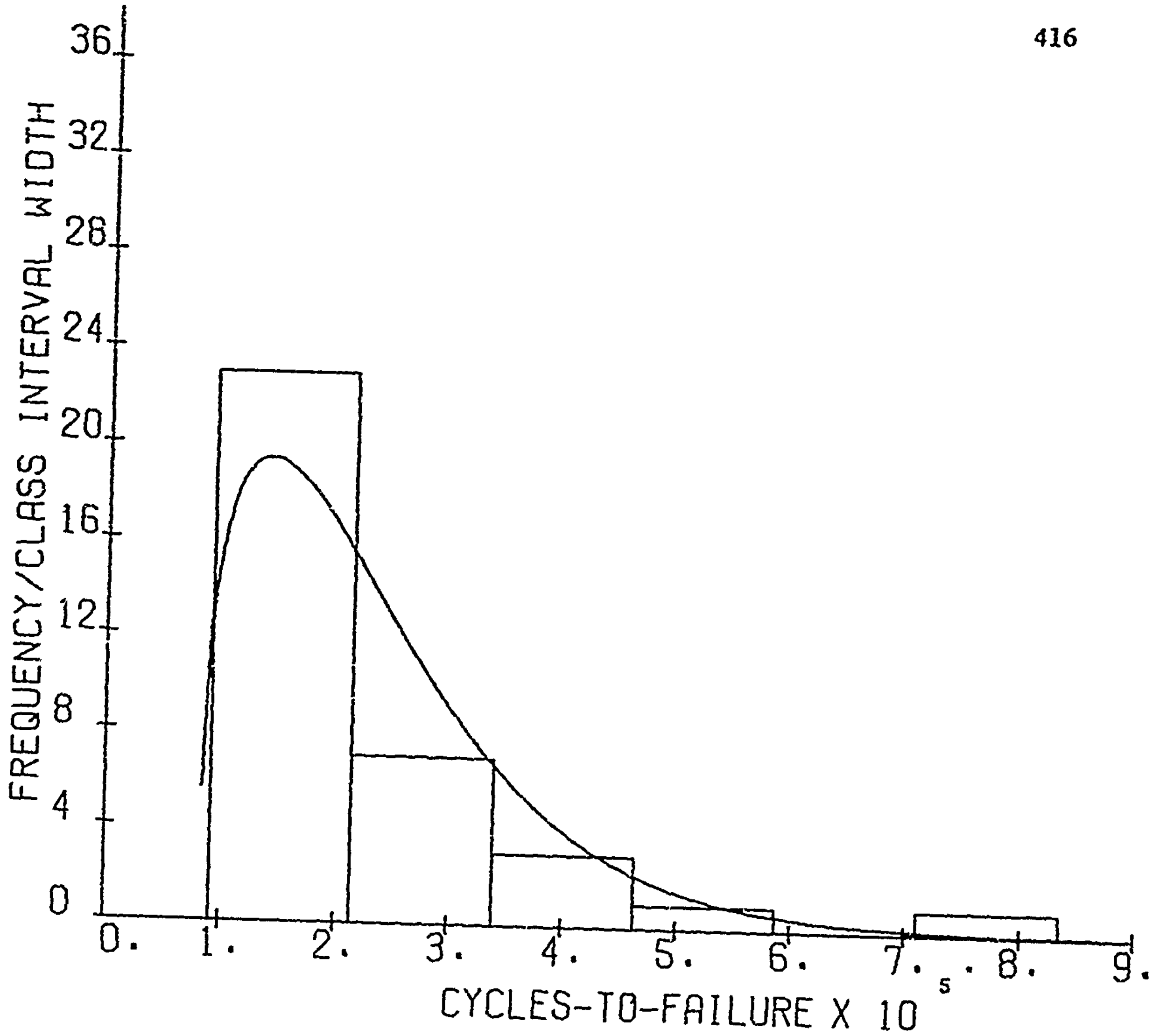
FIG. 9.1-23 CYCLES-TO- FAILURE DIST OF GROUP NO. 138 USING WIRE MACHINE NO. 2 FOR 35 SPECIMENS OF .040 IN. DIAMETER AISI 1038 STEEL WIRE. FIXED ALTERNATING STRESS LEVEL OF 69,200 PSI. BEND ANGLE 18.0 DEGREES. COAST DOWN CYCLES 200.



MEAN VALUE:	12.248	CYCLES
STANDARD DEVIATION:	0.473	CYCLES
KOLMOGOROV-SMIRNOV TEST:	0.164	
CHI-SQUARED TEST:	0.605	
SKEWNESS:	0.834	
KURTOSIS:	3.831	

FIG. 9.1-24 CYCLES-TO- FAILURE DIST OF GROUP NO. 138 USING WIRE MACHINE NO. 2 FOR 35 SPECIMENS OF .040 IN. DIAMETER AISI 1038 STEEL WIRE. FIXED ALTERNATING STRESS LEVEL OF 69,200 PSI. BEND ANGLE 18.0 DEGREES. COAST DOWN CYCLES 200.

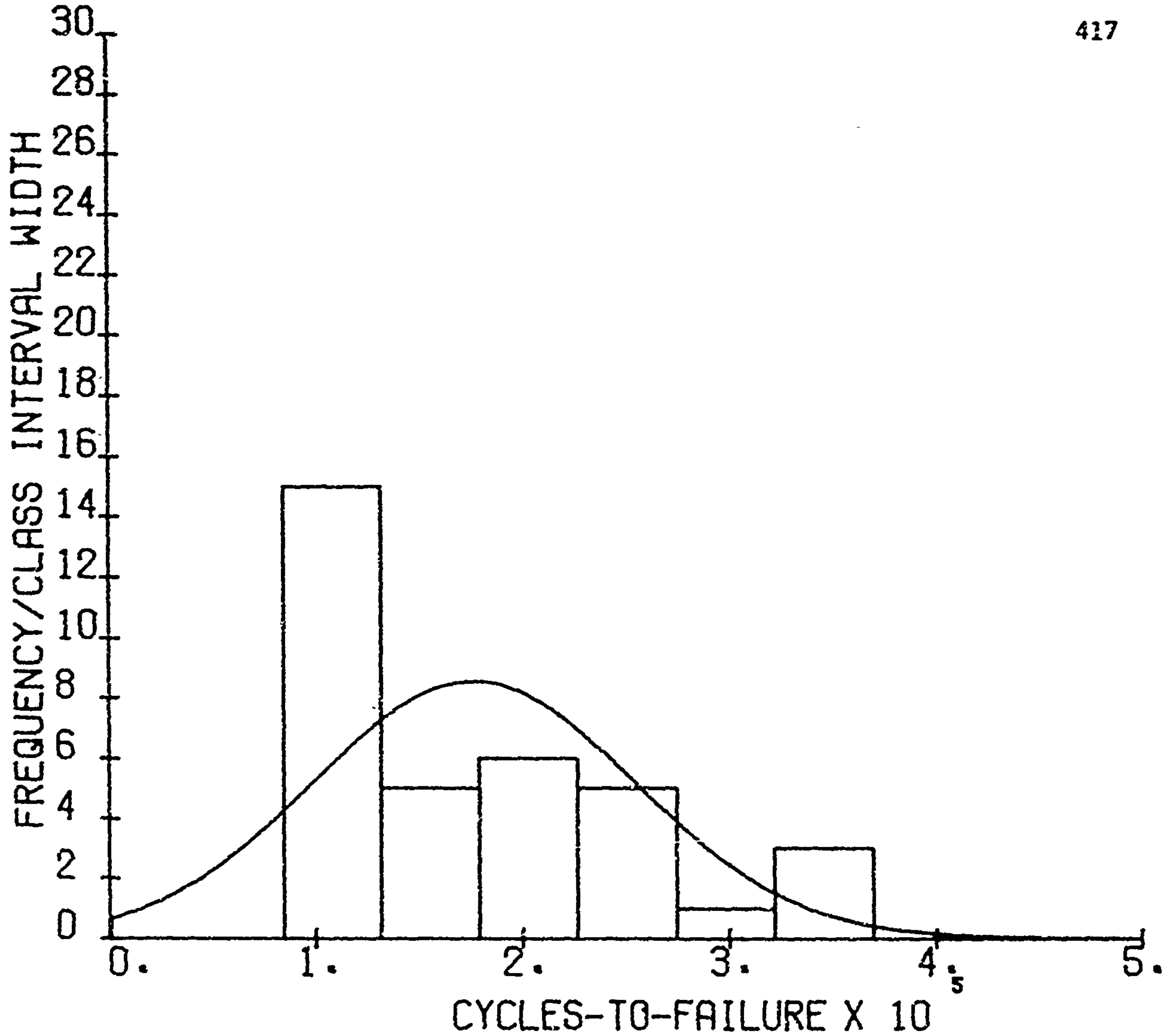
WEIBULL DISTRIBUTION PARAMETERS



KOLMOGOROV-SMIRNOV TEST: 0.166
CHI-SQUARED TEST: 5.267
WEIBULL SLOPE (BETA): 1.328
MINIMUM LIFE (GAMMA): 83399
SCALE PARAMETER (ETA): 163986

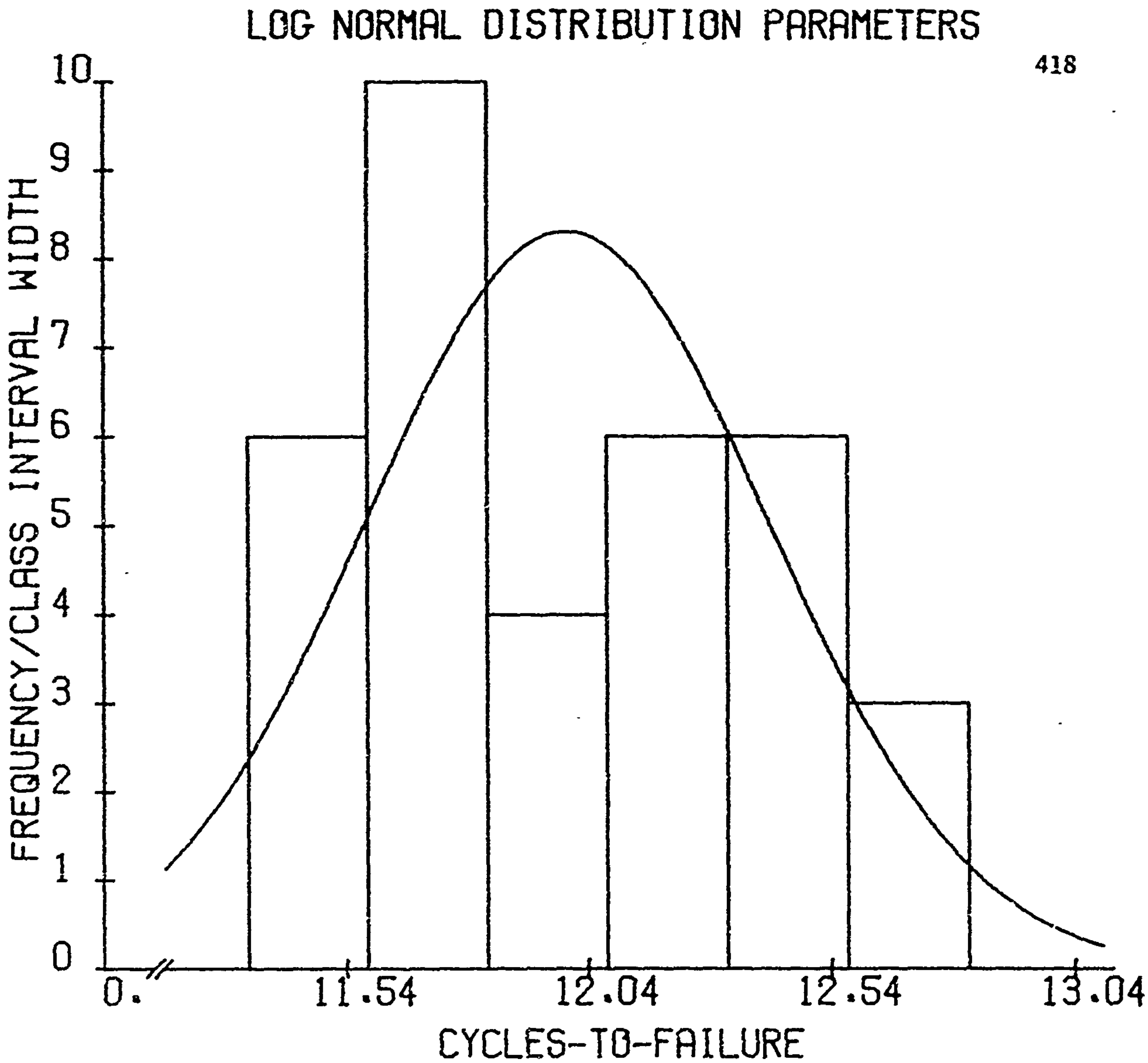
FIG. 9.1-25 CYCLES-TO-FAILURE DISTRIBUTION
GROUP=138
SL=69200 PSI

NORMAL DISTRIBUTION PARAMETERS



MEAN VALUE:	176505.7	CYCLES
STANDARD DEVIATION:	77774.2	CYCLES
KOLMOGOROV-SMIRNOV TEST:	0.166	
CHI-SQUARED TEST:	4.418	
SKEWNESS:	0.929	
KURTOSIS:	2.997	

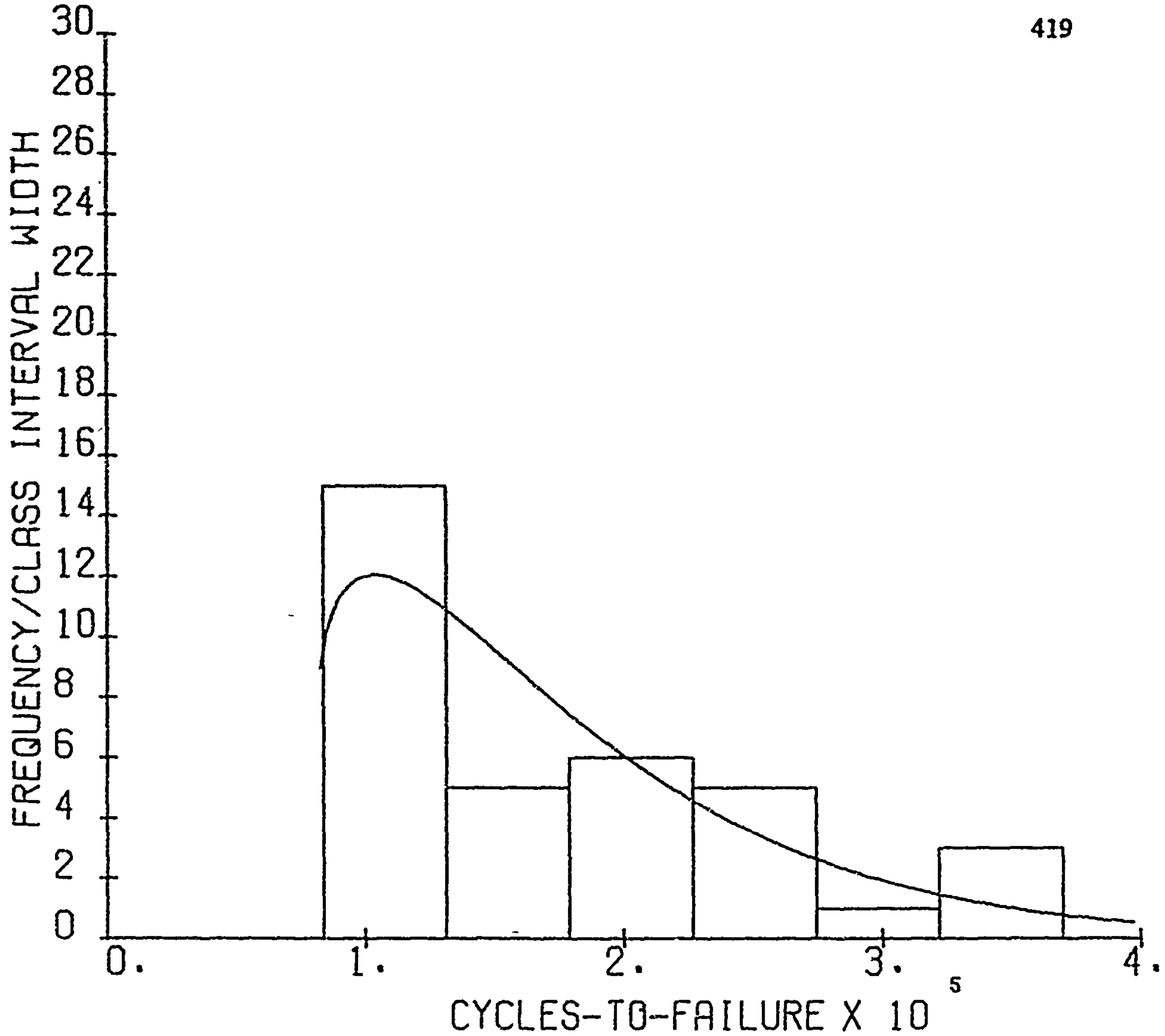
FIG. 9-1-26 CYCLES-TO-FAILURE DIST OF GROUP NO= 139 USING WIRE MACHINE NO. 2 FOR 35 SPECIMENS OF .040 IN. DIAMETER AISI 1038 STEEL WIRE. FIXED ALTERNATING STRESS LEVEL OF 72,300 PSI. BEND ANGLE 18.5 DEGREES. COAST DOWN CYCLES 200



MEAN VALUE:	11.994	CYCLES
STANDARD DEVIATION:	0.416	CYCLES
KOLMOGOROV-SMIRNOV TEST:	0.135	
CHI-SQUARED TEST:	4.574	
SKEWNESS:	0.348	
KURTOSIS:	1.985	

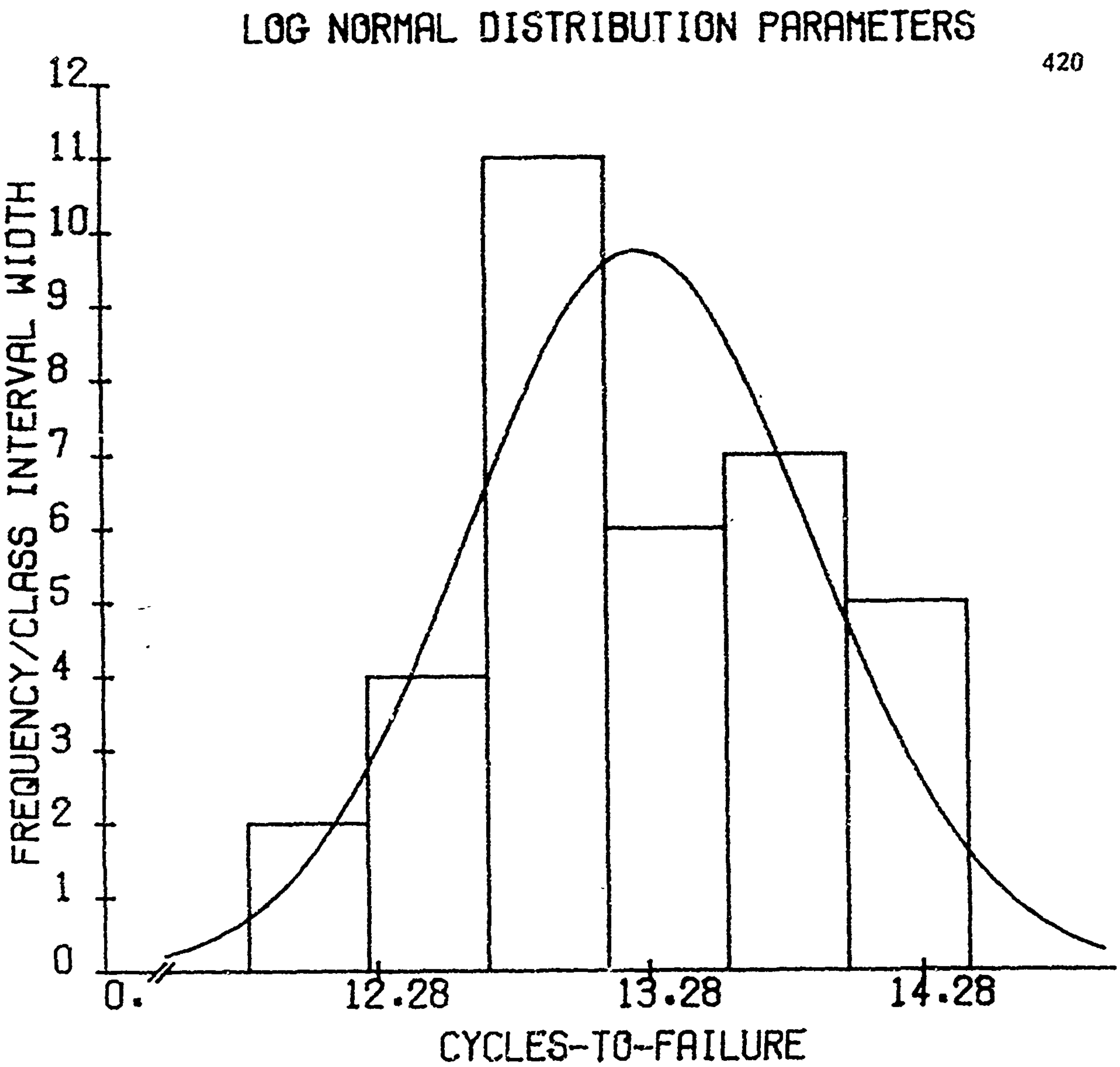
FIG. 9.1-27 CYCLES-TO-FAILURE DIST OF GROUP NO= 139 USING WIRE MACHINE NO. 2 FOR 35 SPECIMENS OF .040 IN. DIAMETER AISI 1038 STEEL WIRE. FIXED ALTERNATING STRESS LEVEL OF 72,300 PSI. BEND ANGLE 18.5 DEGREES. COAST DOWN CYCLES 200

WEIBULL DISTRIBUTION PARAMETERS



KOLMOGOROV-SMIRNOV TEST: 0.097
CHI-SQUARED TEST: 3.863
WEIBULL SLOPE (BETA): 1.204
MINIMUM LIFE (GAMMA): 80099
SCALE PARAMETER (ETA): 104054

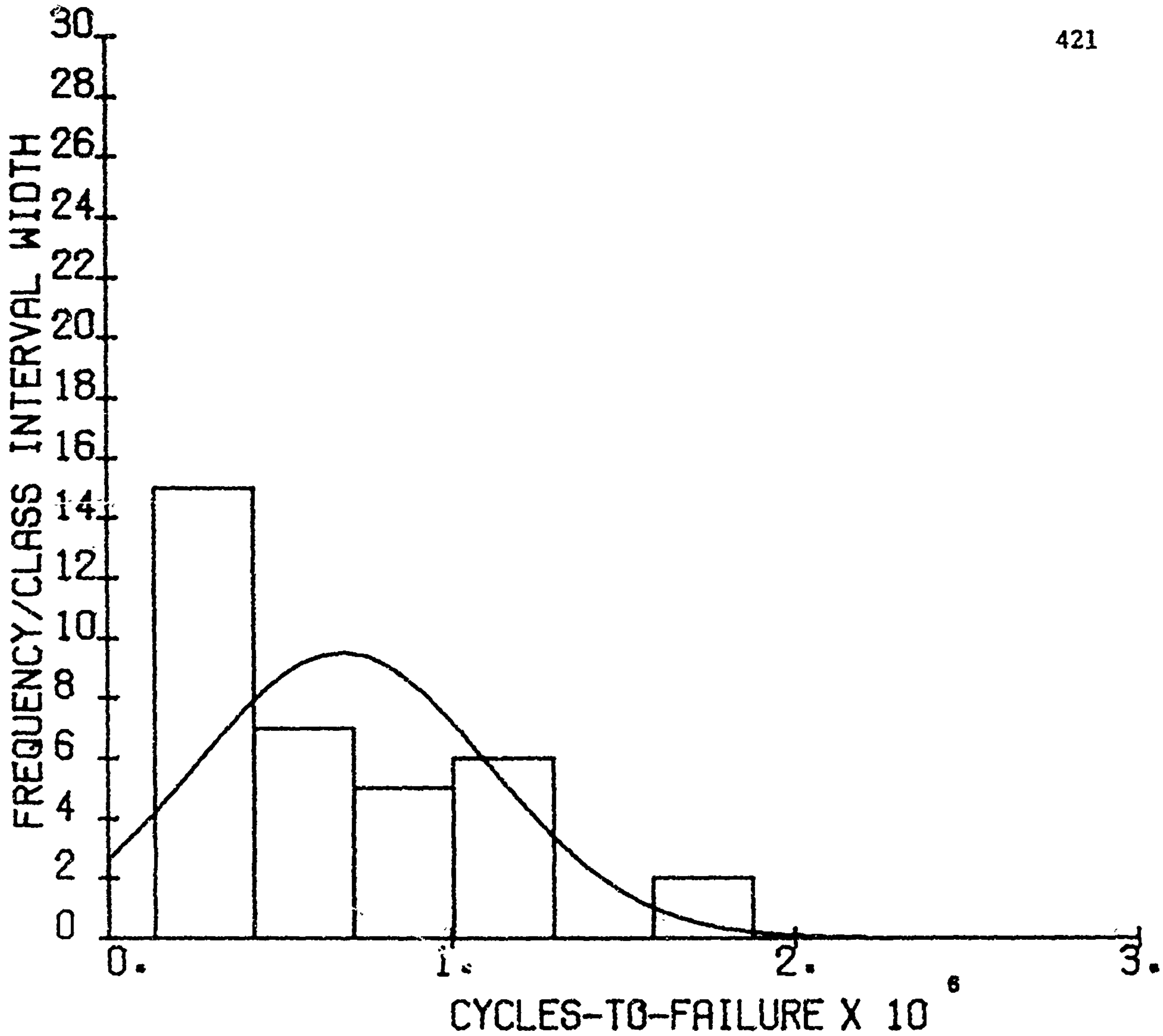
FIG. 9.1-28 CYCLES-TO-FAILURE DISTRIBUTION
GROUP=139
SL=72300 PSI



MEAN VALUE:	13.246	CYCLES
STANDARD DEVIATION:	0.631	CYCLES
KOLMOGOROV-SMIRNOV TEST:	0.106	
CHI-SQUARED TEST:	2.436	
SKEWNESS:	-0.066	
KURTOSIS:	2.397	

FIG. 9.1-29 CYCLES-TO- FAILURE DIST OF GROUP NO. 143 USING WIRE MACHINE NO. 3 FOR 35 SPECIMENS OF .040 IN. DIAMETER AISI 1018 STEEL WIRE. FIXED ALTERNATING STRESS LEVEL OF 57,200 PSI. BEND ANGLE 15.5 DEGREES. COAST DOWN CYCLES 200.

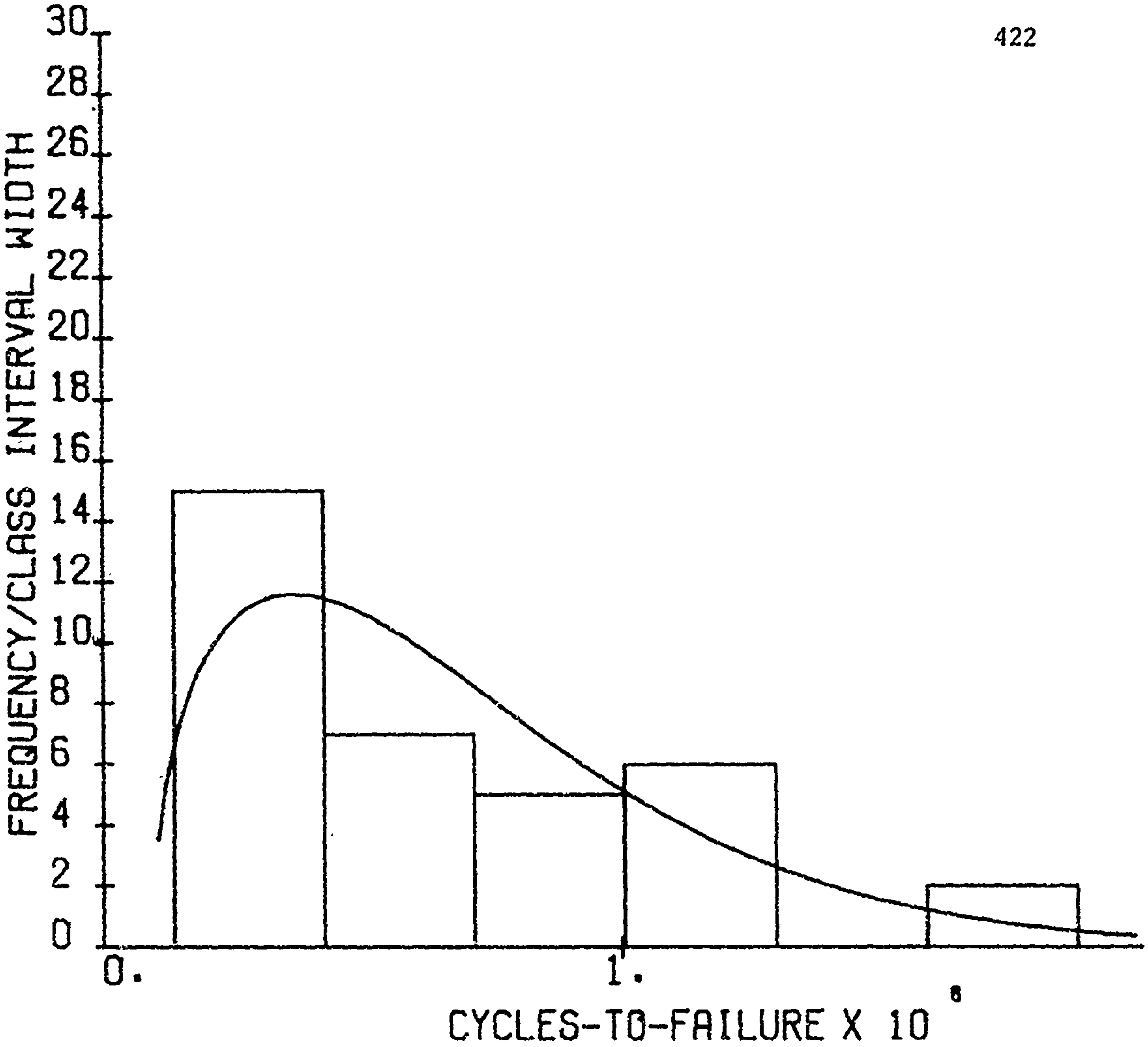
NORMAL DISTRIBUTION PARAMETERS



MEAN VALUE:	681940.0	CYCLES
STANDARD DEVIATION:	427001.5	CYCLES
KOLMOGOROV-SMIRNOV TEST:	0.177	
CHI-SQUARED TEST:	5.029	
SKEWNESS:	1.034	
KURTOSIS:	3.416	

FIG. 9.1-30 CYCLES-TO- FAILURE DIST OF GROUP NO. 143 USING WIRE MACHINE NO. 3 FOR 35 SPECIMENS OF .040 IN. DIAMETER AISI 1018 STEEL WIRE. FIXED ALTERNATING STRESS LEVEL OF 57,200 PSI. BEND ANGLE 15.5 DEGREES. COAST DOWN CYCLES 200.

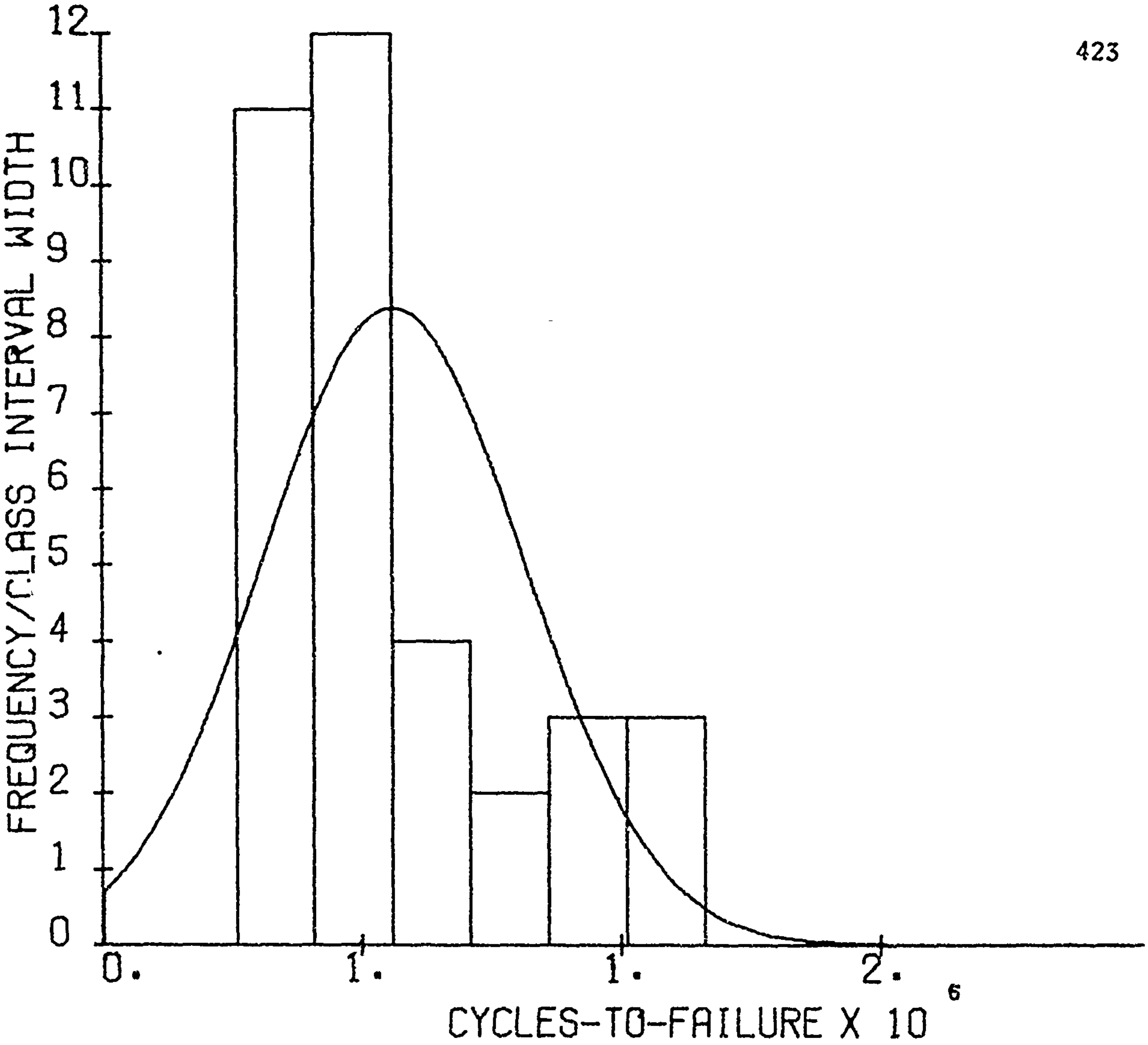
WEIBULL DISTRIBUTION PARAMETERS



KOLMOGOROV-SMIRNOV TEST: 0.114
CHI-SQUARED TEST: 3.724
WEIBULL SLOPE (BETA): 1.415
MINIMUM LIFE (GAMMA): 98999
SCALE PARAMETER (ETA): 645345

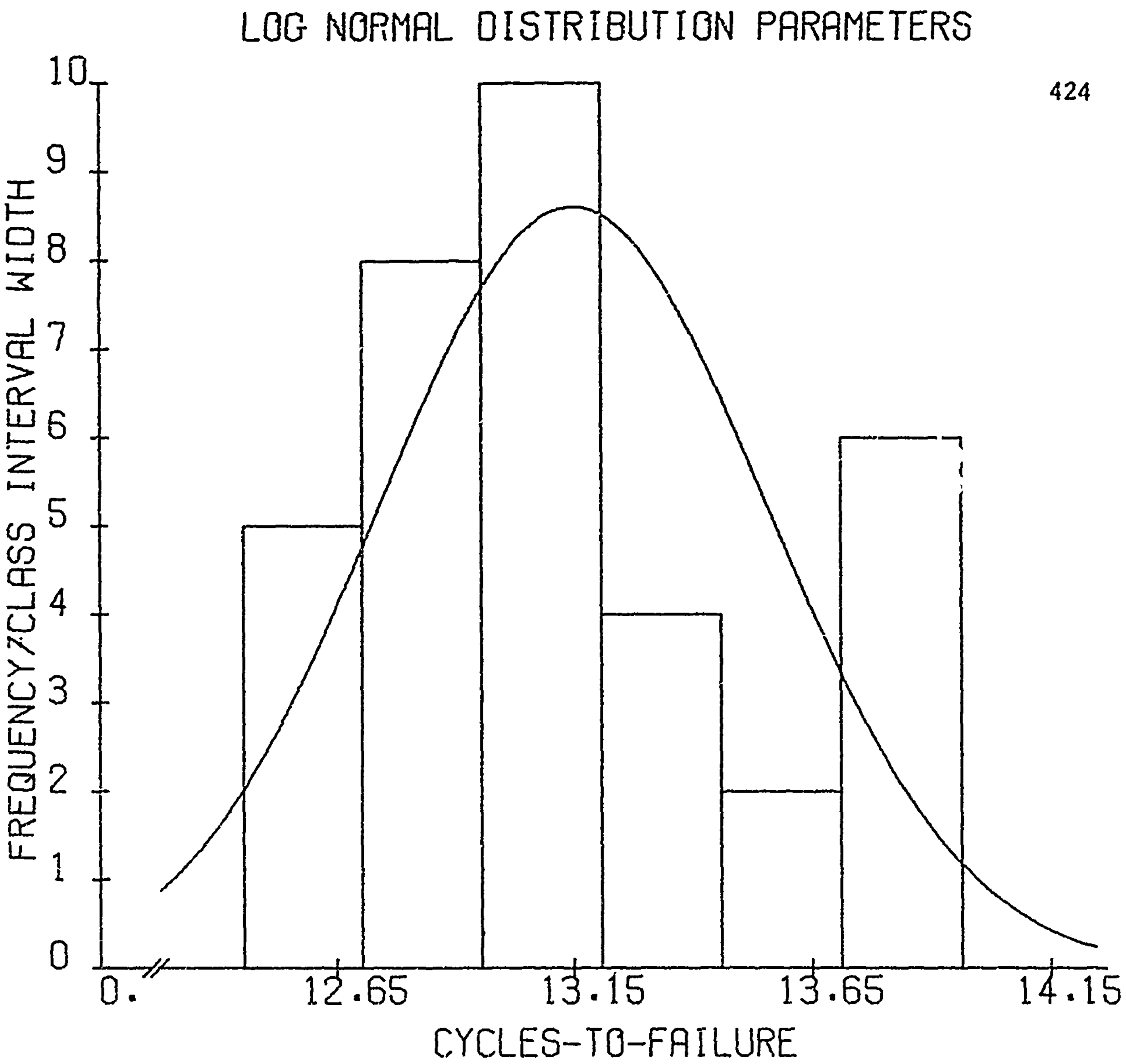
FIG. 9.1-31 CYCLES-TO-FAILURE DISTRIBUTION
GROUP=143
SL=57200 PSI

NORMAL DISTRIBUTION PARAMETERS



MEAN VALUE: 560405.7 CYCLES
STANDARD DEVIATION: 251043.6 CYCLES
KOLMOGOROV-SMIRNOV TEST: 0.192
CHI-SQUARED TEST: 7.570
SKEWNESS: 1.126
KURTOSIS: 3.245

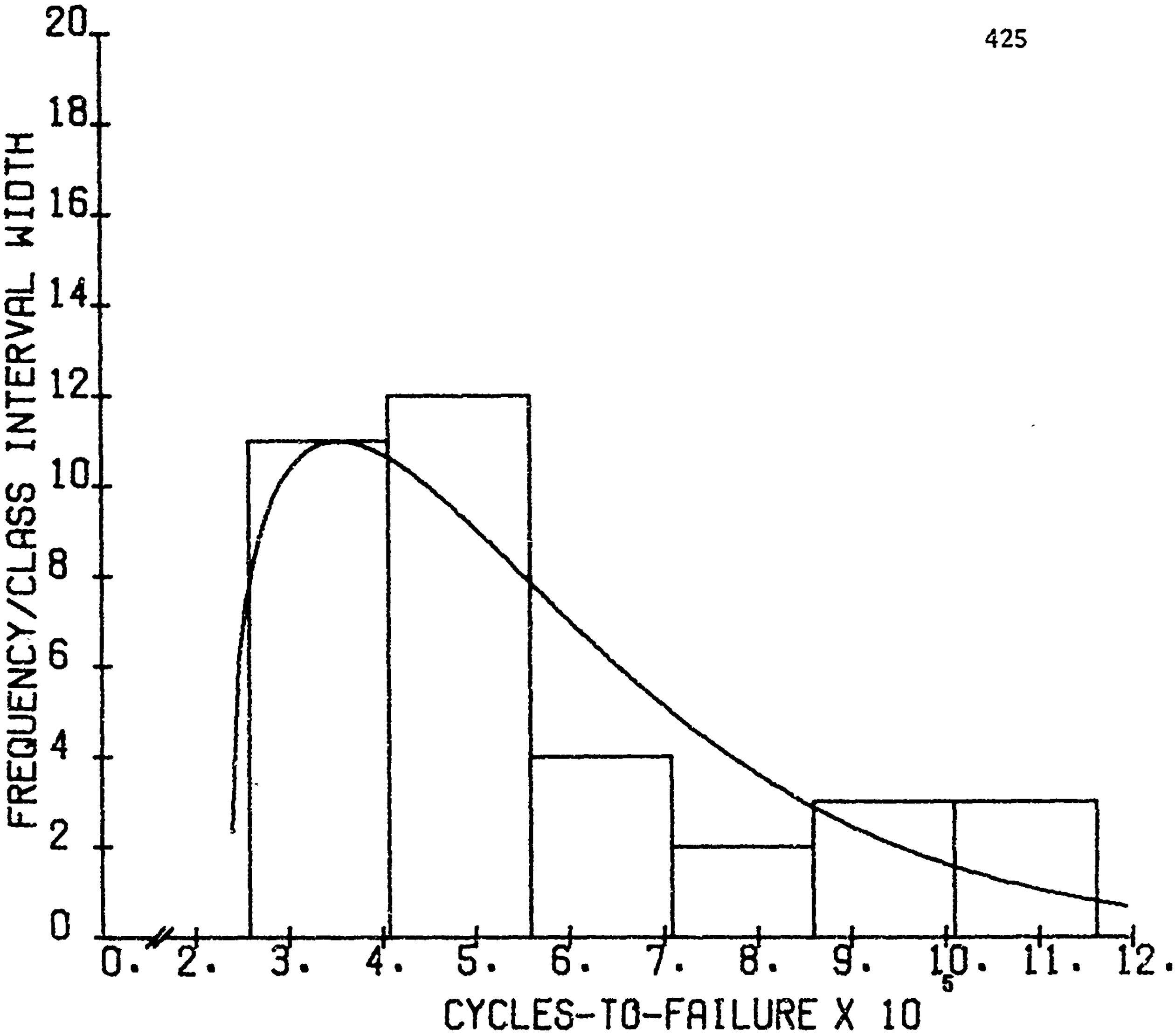
FIG. 9.1-32 CYCLES-TO-FAILURE DIST OF GROUP NO. 144 USING WIRE MACHINE NO. 3 FOR 35 SPECIMENS OF .040 IN. DIAMETER AISI 1018 STEEL WIRE . FIXED ALTERNATING STRESS LEVEL OF 60,000 PSI. BEND ANGLE 16.0 DEGREES. COAST DOWN CYCLES 100.



MEAN VALUE:	13.151	CYCLES
STANDARD DEVIATION:	0.409	CYCLES
KOLMOGOROV-SMIRNOV TEST:	0.125	
CHI-SQUARED TEST:	7.380	
SKEWNESS:	0.466	
KURTOSIS:	2.464	

FIG. 9.1-33 CYCLES-TO-FAILURE DIST OF GROUP NO. 144 USING WIRE MACHINE NO. 3 FOR 35 SPECIMENS OF .040 IN. DIAMETER AISI 1018 STEEL WIRE . FIXED ALTERNATING STRESS LEVEL OF 60,000 PSI. BEND ANGLE 16.0 DEGREES. COAST DOWN CYCLES 100.

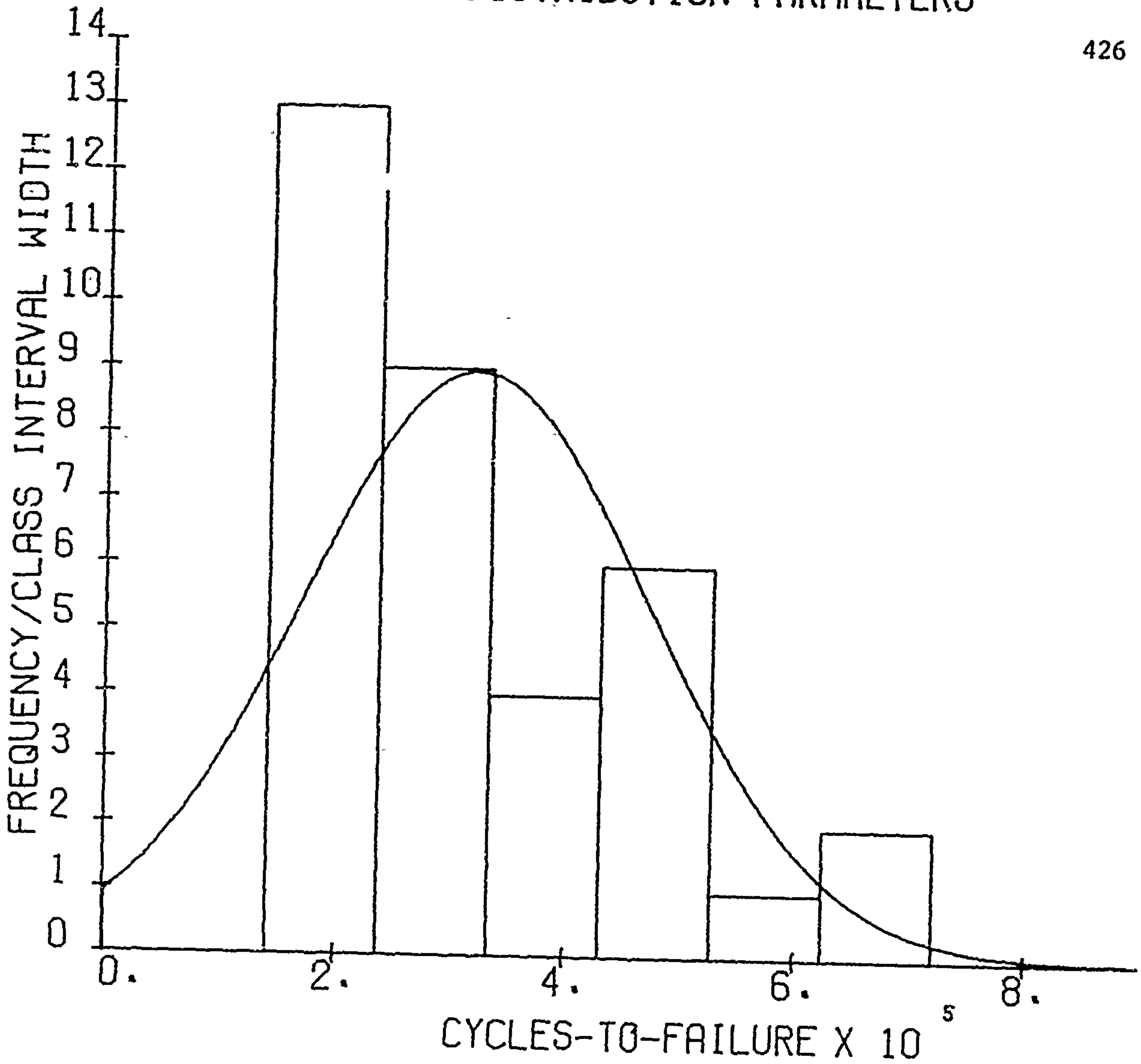
WEIBULL DISTRIBUTION PARAMETERS



KOLMOGOROV-SMIRNOV TEST: 0.107
CHI-SQUARED TEST: 4.112
WEIBULL SLOPE (BETA): 1.303
MINIMUM LIFE (GAMMA): 238999
SCALE PARAMETER (ETA): 353483

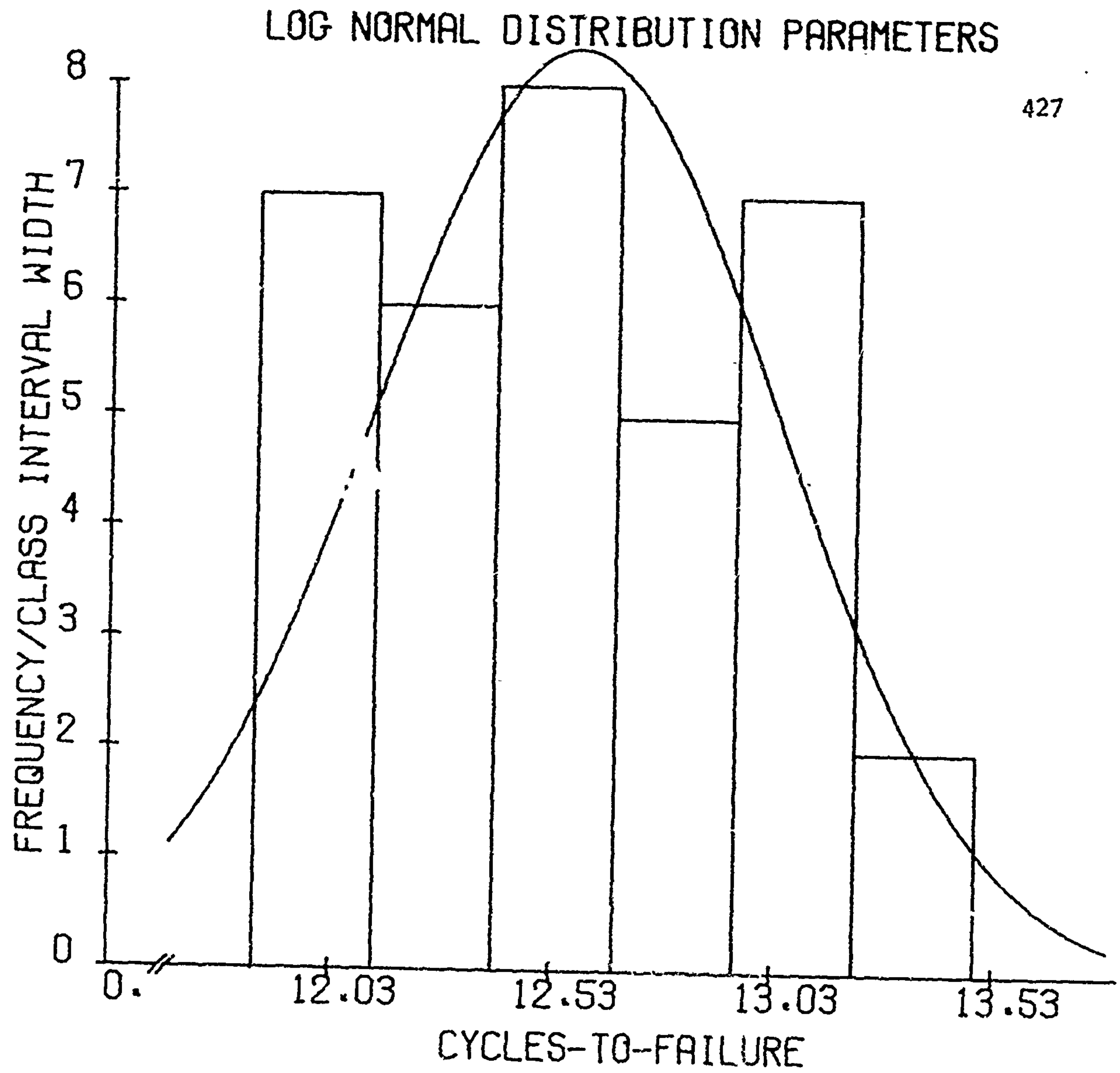
FIG. 9.1-34 CYCLES-TO-FAILURE DISTRIBUTION
GROUP=144
SL=60000 PSI

NORMAL DISTRIBUTION PARAMETERS



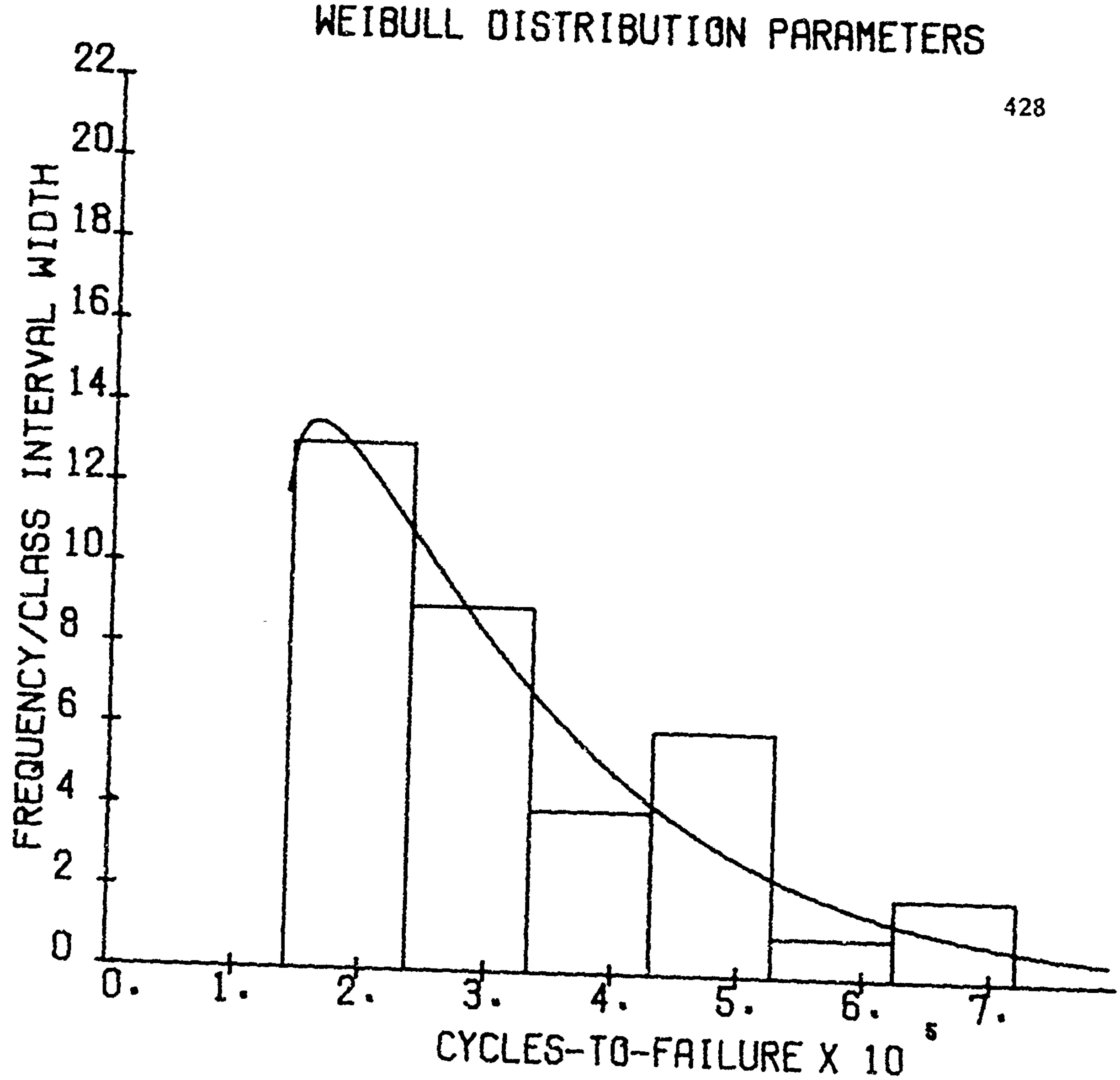
MEAN VALUE:	321568.6 CYCLES
STANDARD DEVIATION:	150632.0 CYCLES
KOLMOGOROV-SMIRNOV TEST:	0.153
CHI-SQUARED TEST:	3.037
SKEWNESS:	0.821
KURTOSIS:	2.824

FIG. 9.1-35 CYCLES-TO-FAILURE DIST OF GROUP NO= 145 USING WIRE MACHINE NO. 3 FOR 35 SPECIMENS OF .040 IN. DIAMETER AISI 1018 STEEL WIRE. FIXED ALTERNATING STRESS LEVEL OF 62,800 PSI. BEND ANGLE 16.5 DEGREES. COAST DOWN CYCLES 200



MEAN VALUE:	12.579	CYCLES
STANDARD DEVIATION:	0.455	CYCLES
KOLMOGOROV-SMIRNOV TEST:	0.105	
CHI-SQUARED TEST:	1.435	
SKEWNESS:	0.205	
KURTOSIS:	1.885	

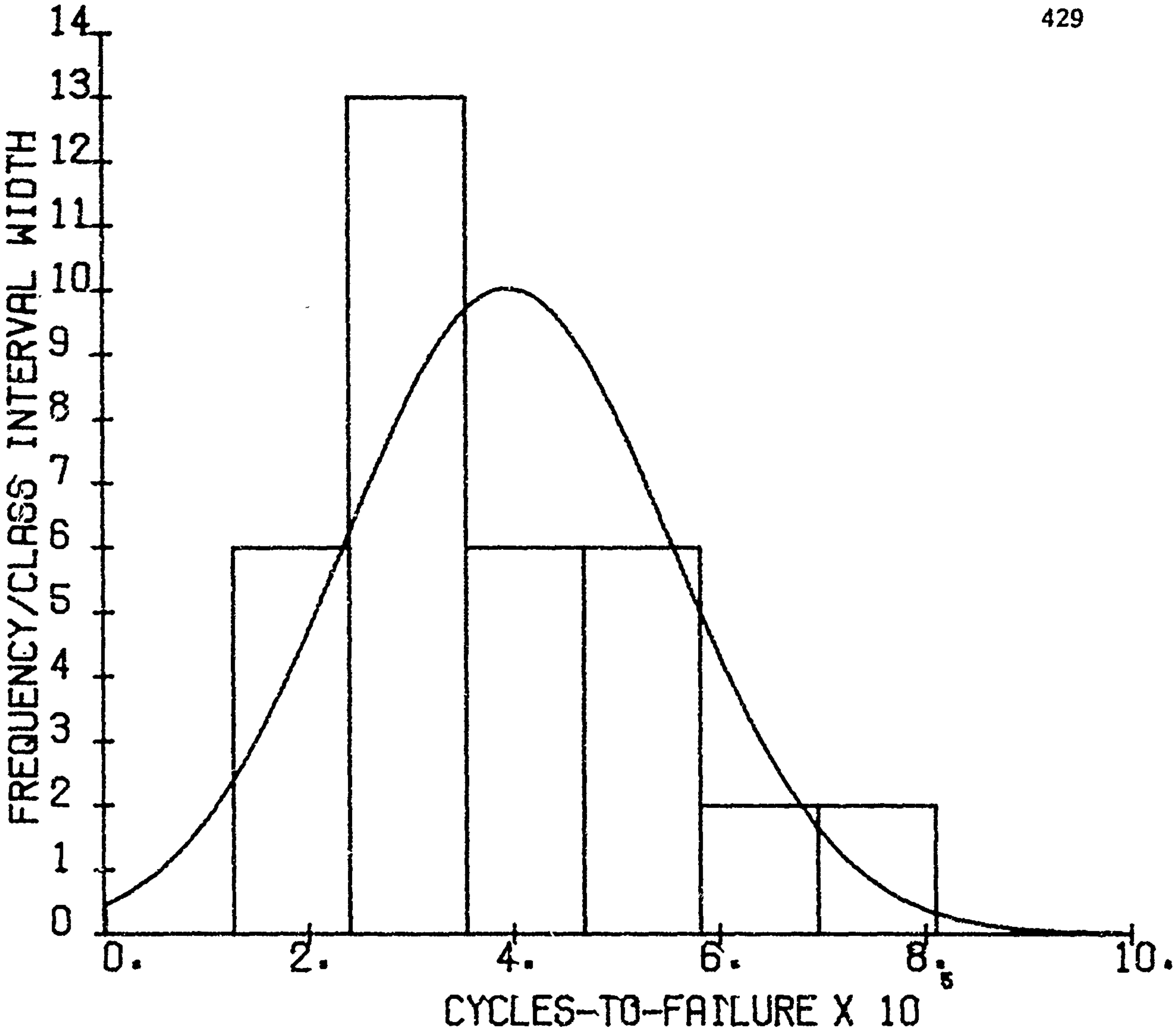
FIG. 9.1-36 CYCLES-TO-FAILURE DIST OF GROUP NO= 145 USING WIRE MACHINE NO. 3 FOR 35 SPECIMENS OF .040 IN. DIAMETER AISI 1018 STEEL WIRE. FIXED ALTERNATING STRESS LEVEL OF 62,800 PSI. BEND ANGLE 16.5 DEGREES. COAST DOWN CYCLES 200



KOLMOGOROV-SMIRNOV TEST: 0.064
CHI-SQUARED TEST: 2.546
WEIBULL SLOPE (BETA): 1.111
MINIMUM LIFE (GAMMA): 135499
SCALE PARAMETER (ETA): 199629

FIG. 9.1-37 CYCLES-TO-FAILURE DISTRIBUTION
GROUP=145
SL=62800 PSI

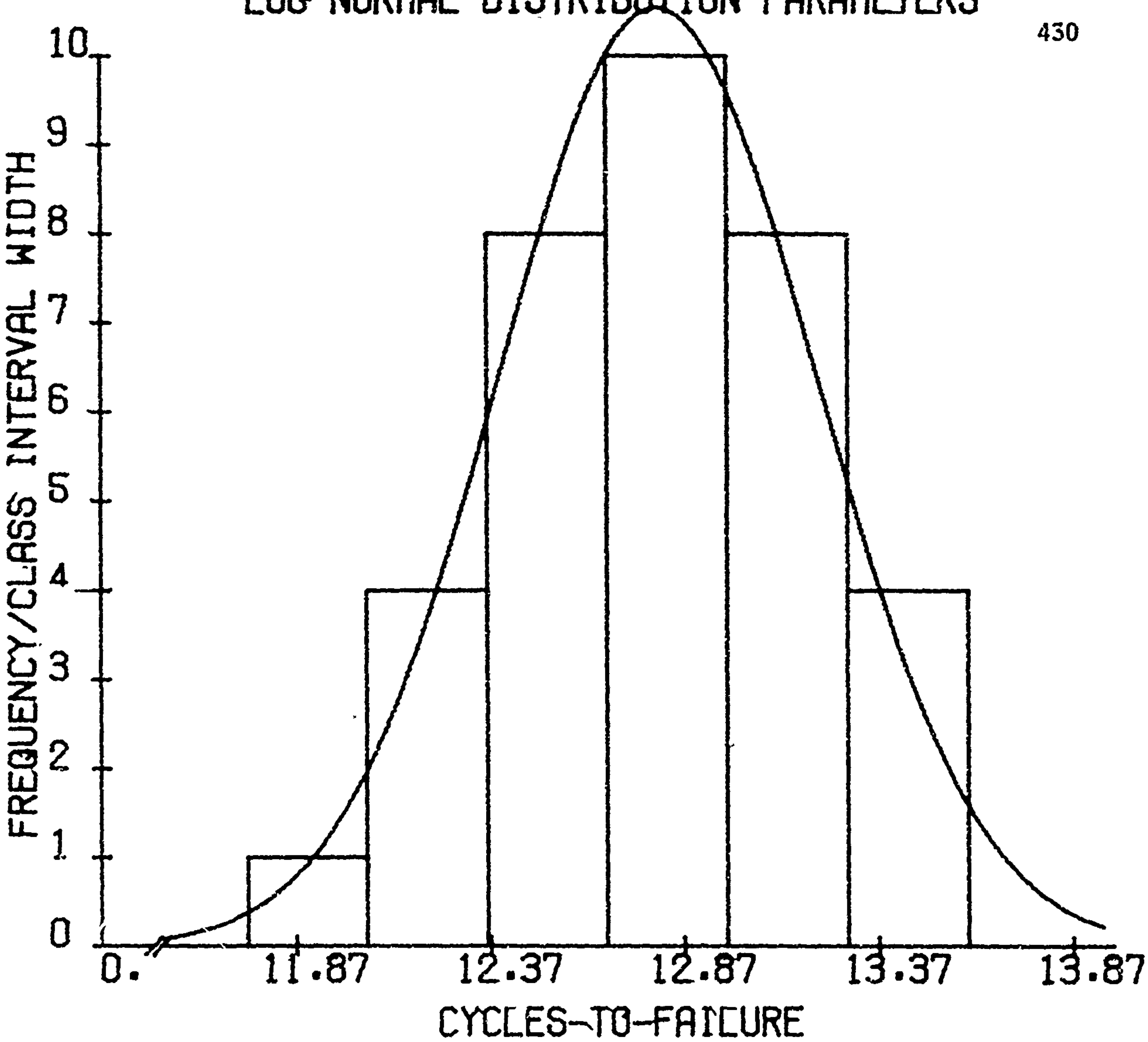
NORMAL DISTRIBUTION PARAMETERS



MEAN VALUE: 394545.7 CYCLES
STANDARD DEVIATION: 158482.8 CYCLES
KOLMOGOROV-SMIRNOV TEST: 0.165
CHI-SQUARED TEST: 4.420
SKEWNESS: 0.717
KURTOSIS: 2.993

FIG. 9.1-40 CYCLES-TO-FAILURE DIST OF GROUP NO. 150
USING WIRE MACHINE NO. 4 FOR
35 SPECIMENS OF .040 IN. DIAMETER AISI
4340 STEEL WIRE . FIXED ALTERNATING
STRESS LEVEL OF 73,500 PSI. BEND ANGLE
20.5 DEGREES. COAST DOWN CYCLES 100.

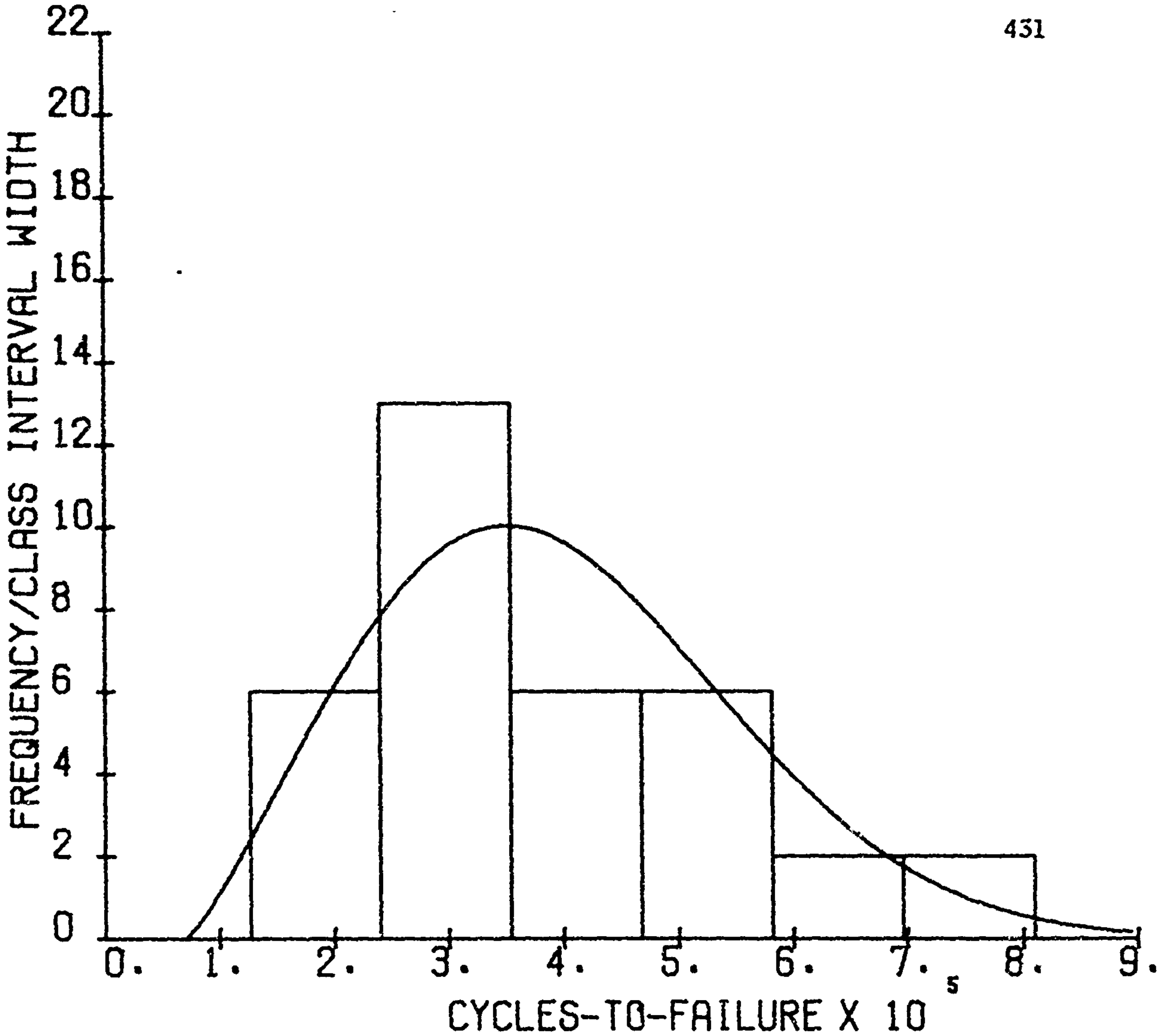
LOG NORMAL DISTRIBUTION PARAMETERS



MEAN VALUE: 12.807 CYCLES
STANDARD DEVIATION: 0.410 CYCLES
KOLMOGOROV-SMIRNOV TEST: 0.095
CHI-SQUARED TEST: 0.026
SKEWNESS: -0.236
KURTOSIS: 2.905

FIG. 9.1-41 CYCLES-TO-FAILURE DIST OF GROUP NO. 150 USING WIRE_MACHINE NO. 4 FOR 35 SPECIMENS OF .040 IN. DIAMETER AISI 4340 STEEL WIRE . FIXED ALTERNATING STRESS LEVEL OF 73,500 PSI. BEND ANGLE 20.5 DEGREES. COAST DOWN CYCLES 100.

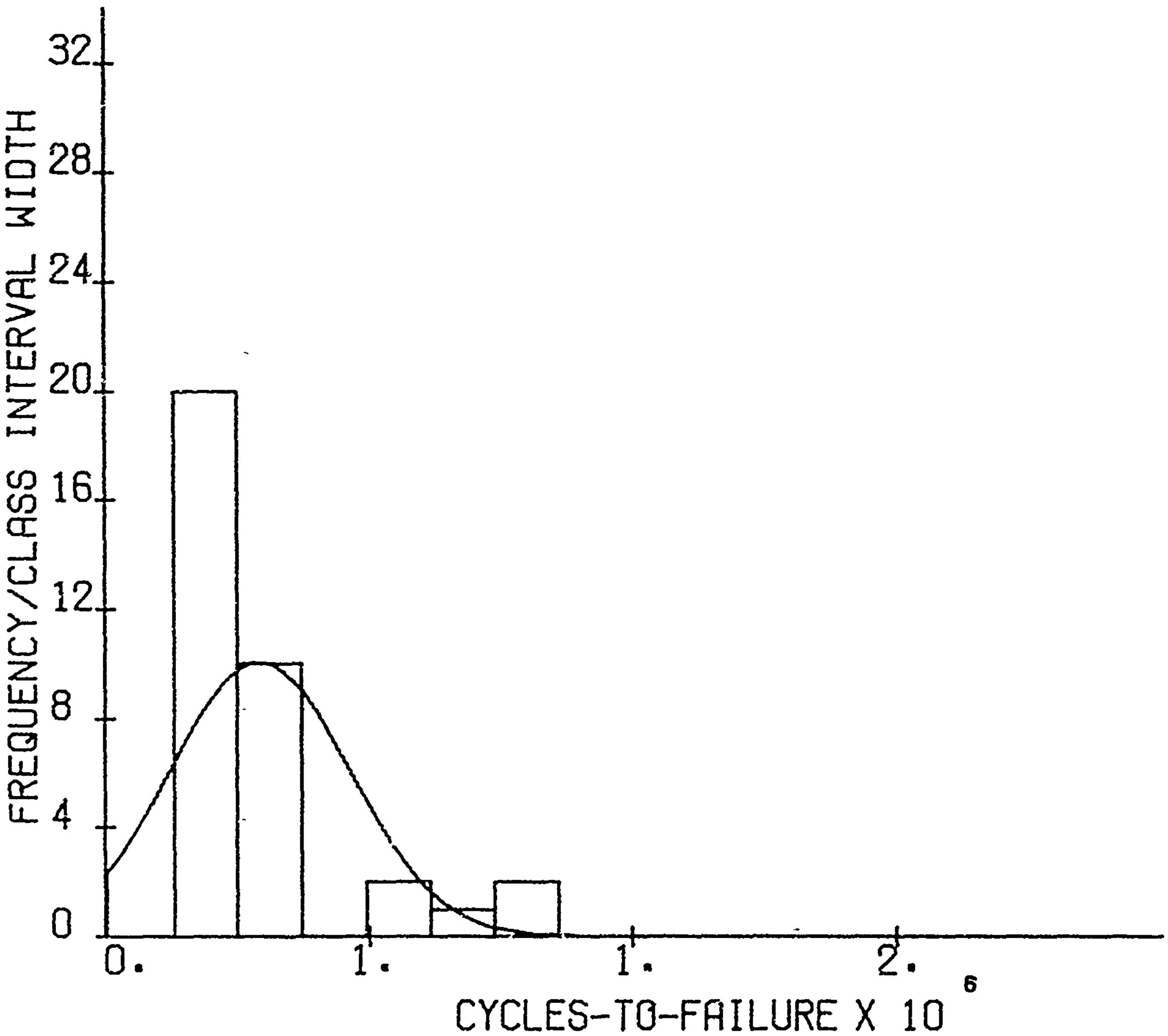
WEIBULL DISTRIBUTION PARAMETERS



KOLMOGOROV-SMIRNOV TEST: 0.134
CHI-SQUARED TEST: 3.075
WEIBULL SLOPE (BETA): 2.230
MINIMUM LIFE (GAMMA): 69599
SCALE PARAMETER (ETA): 367757

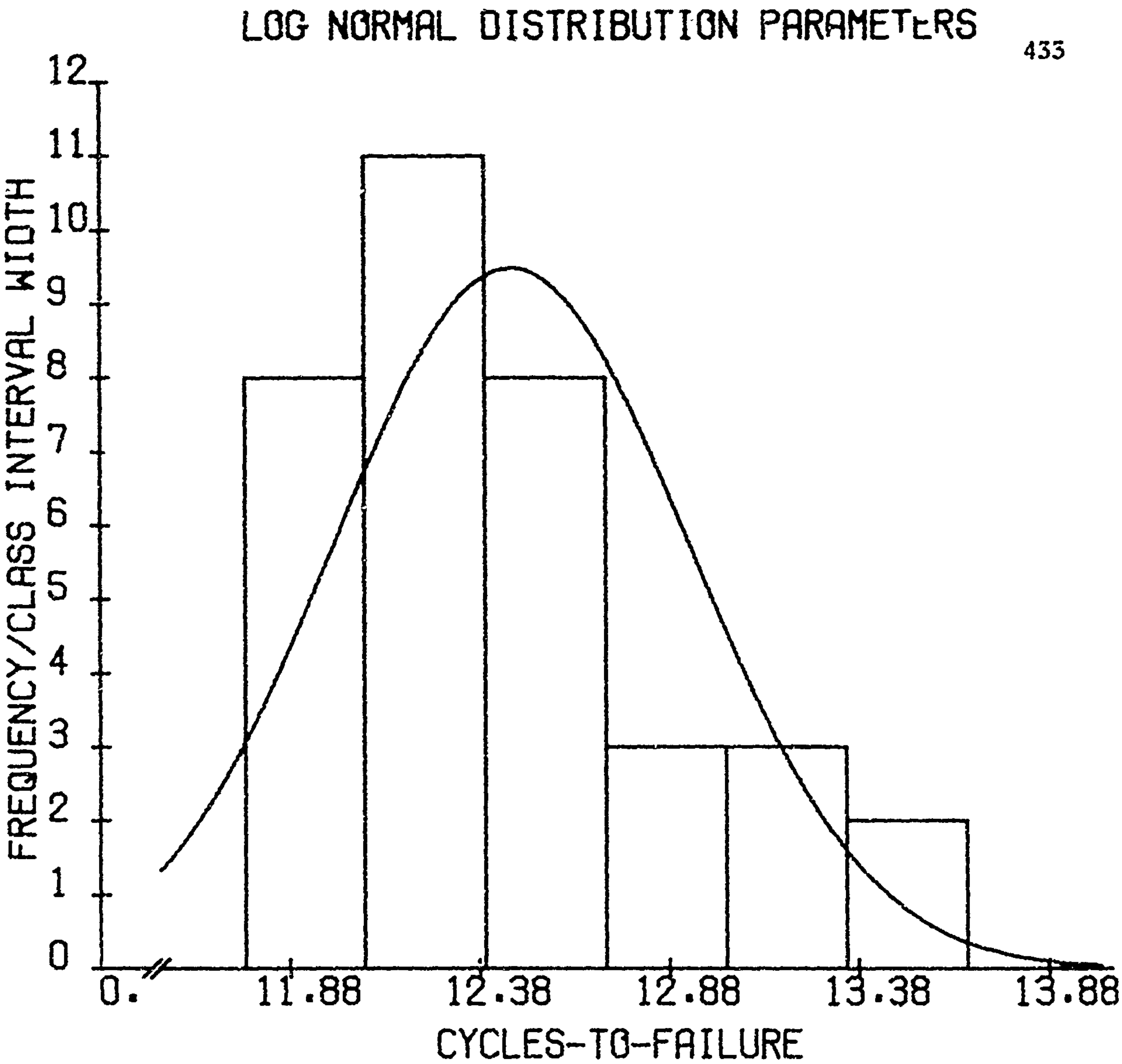
FIG. 9.1-42 CYCLES-TO-FAILURE DISTRIBUTION
SL=73500 PSI
GROUP=150

NORMAL DISTRIBUTION PARAMETERS



MEAN VALUE:	292180.0	CYCLES
STANDARD DEVIATION:	169598.8	CYCLES
KOLMOGOROV-SMIRNOV TEST:	0.221	
CHI-SQUARED TEST:	9.768	
SKEWNESS:	1.912	
KURTOSIS:	6.213	

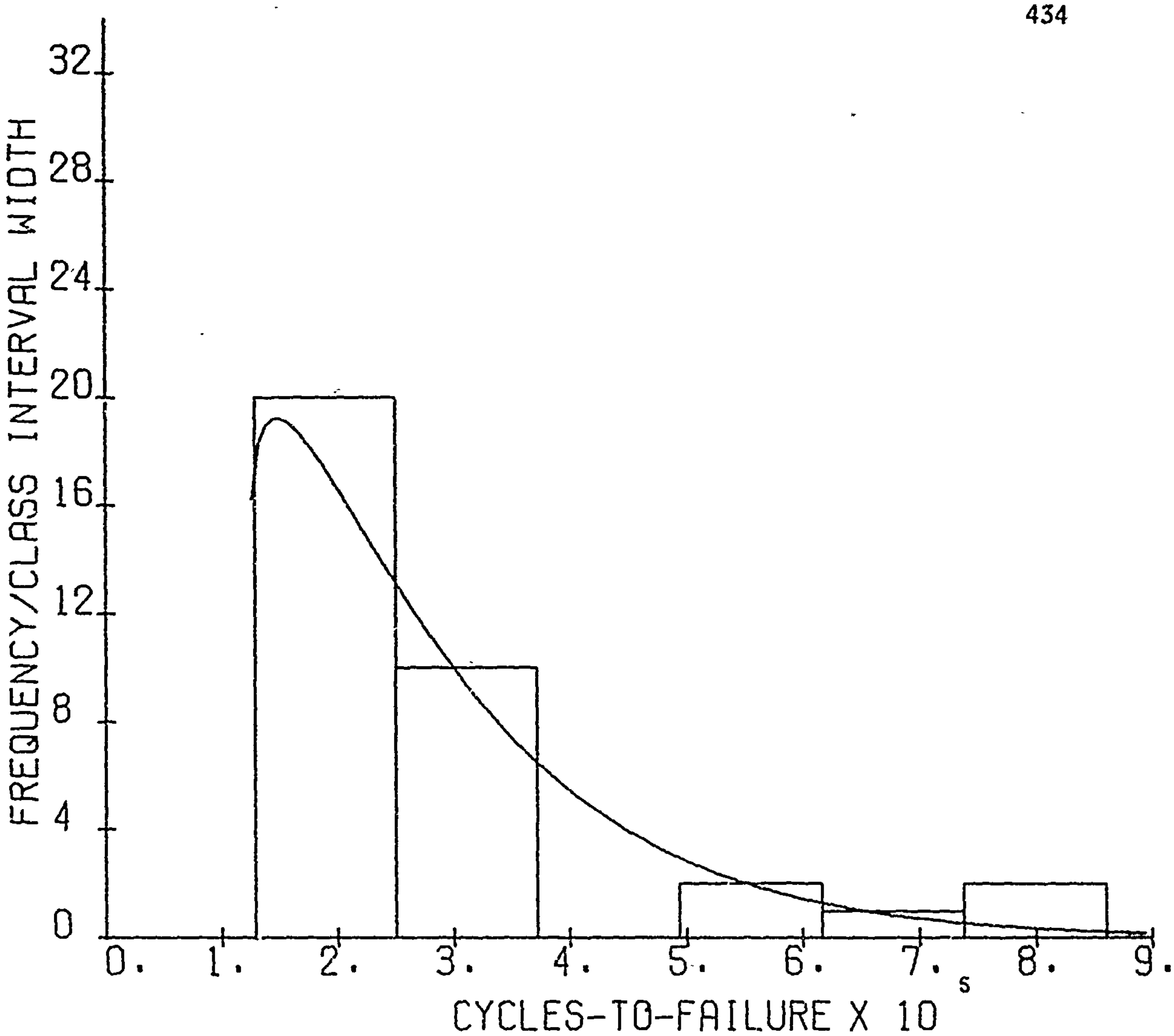
FIG. 9.1-43 CYCLES-TO-FAILURE DIST OF GROUP NO. 151 USING WIRE FATIGUE MACHINE NO. 4 FOR 35 SPECIMENS OF .040 IN. DIAMETER AISI 4340 STEEL WIRE. FIXED ALTERNATING STRESS LEVEL OF 78,100 PSI. BEND ANGLE 21.5 DEGREES. COAST-DOWN CYCLES 100.



MEAN VALUE:	12.465	CYCLES
STANDARD DEVIATION:	0.467	CYCLES
KOLMOGOROV-SMIRNOV TEST:	0.123	
CHI-SQUARED TEST:	3.262	
SKEWNESS:	0.860	
KURTOSIS:	3.335	

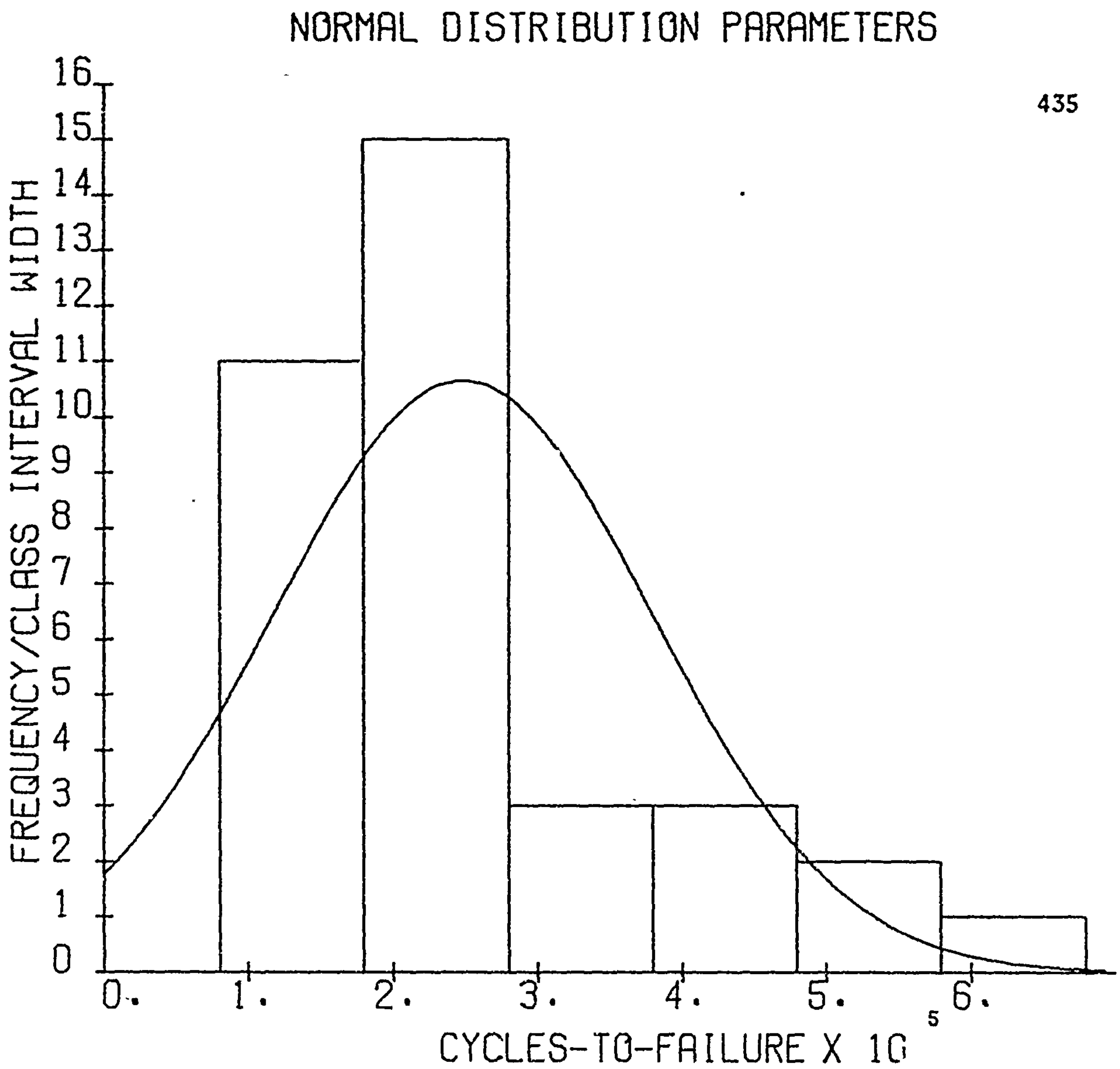
FIG. 9.1-44 CYCLES-TO-FAILURE DIST OF GROUP NO. 151 USING WIRE FATIGUE MACHINE NO. 4 FOR 35 SPECIMENS OF .040 IN. DIAMETER AISI 4340 STEEL WIRE. FIXED ALTERNATING STRESS LEVEL OF 78,100 PSI. BEND ANGLE 21.5 DEGREES. COAST-DOWN CYCLES 100.

WEIBULL DISTRIBUTION PARAMETERS



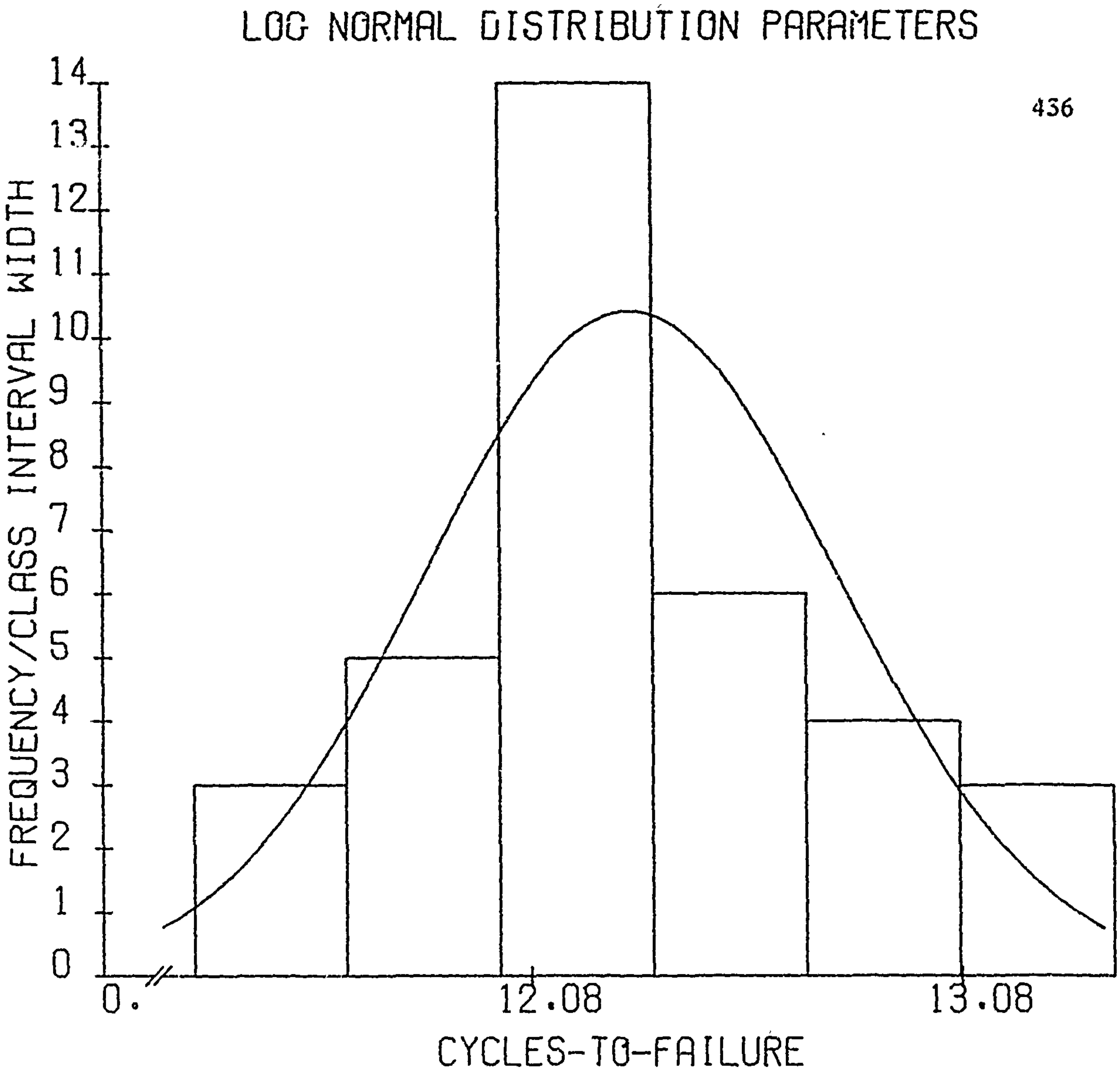
KOLMOGOROV-SMIRNOV TEST: 0.106
CHI-SQUARED TEST: 4.993
WEIBULL SLOPE (BETA): 1.123
MINIMUM LIFE (GAMMA): 123199
SCALE PARAMETER (ETA): 175551

FIG. 9.1-45 CYCLES-TO-FAILURE DISTRIBUTION
SL=78100 PSI
GROUP=151



MEAN VALUE: 248517.1 CYCLES
STANDARD DEVIATION: 130793.5 CYCLES
KOLMOGOROV-SMIRNOV TEST: 0.226
CHI-SQUARED TEST: 5.902
SKEWNESS: 1.524
KURTOSIS: 5.204

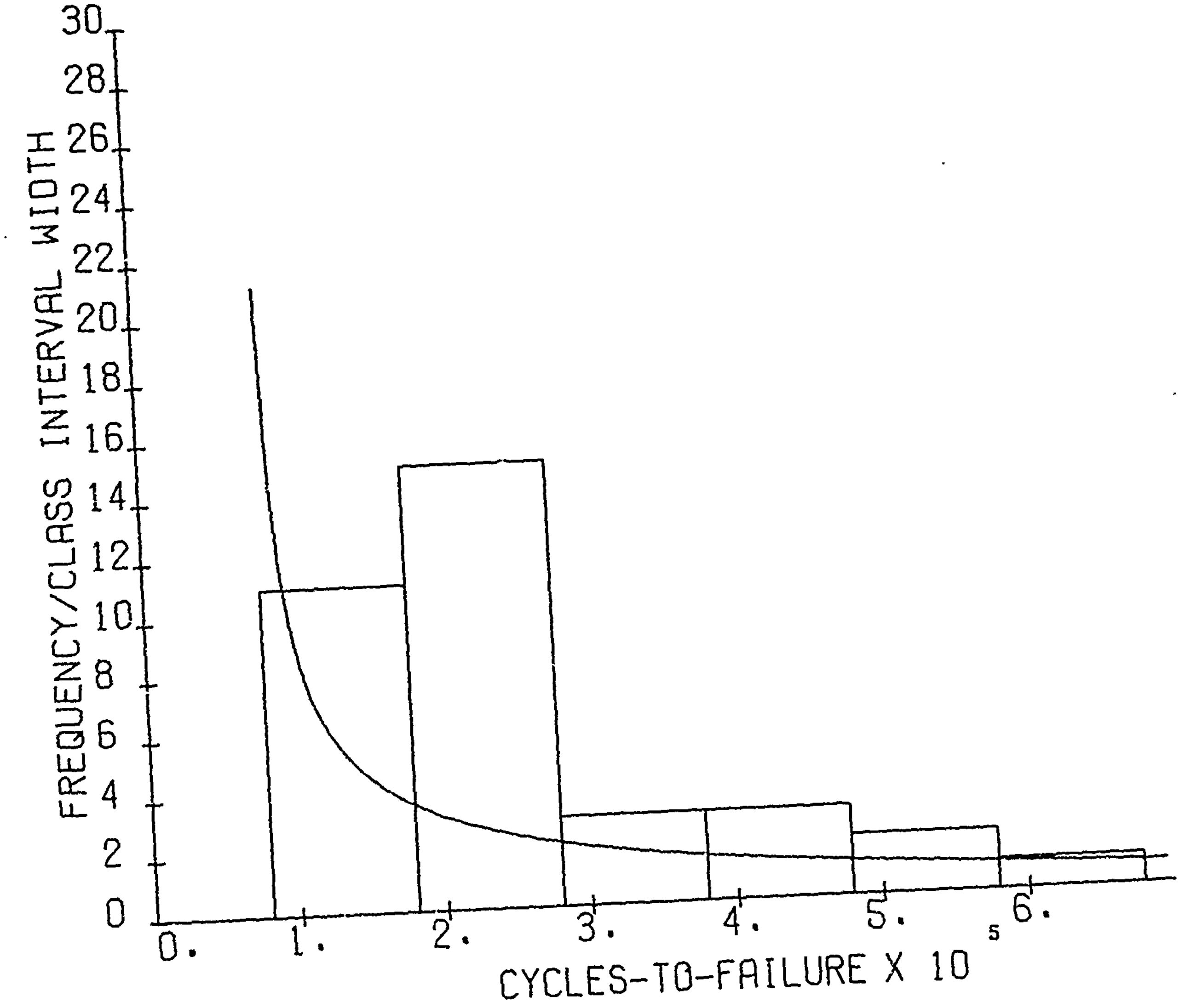
FIG. 9.1-46 CYCLES-TO-FAILURE DIST OF GROUP NO. 152 USING WIRE FATIGUE MACHINE NO. 4 FOR 35 SPECIMENS OF .040 IN. DIAMETER AISI 4340 STEEL WIRE. FIXED ALTERNATING STRESS LEVEL OF 80,100 PSI. BEND ANGLE 22.0 DEGREES. COAST-DOWN CYCLES 100.



MEAN VALUE:	12.309	CYCLES
STANDARD DEVIATION:	0.478	CYCLES
KOLMOGOROV-SMIRNOV TEST:	0.131	
CHI-SQUARED TEST:	2.967	
SKEWNESS:	0.208	
KURTOSIS:	3.130	

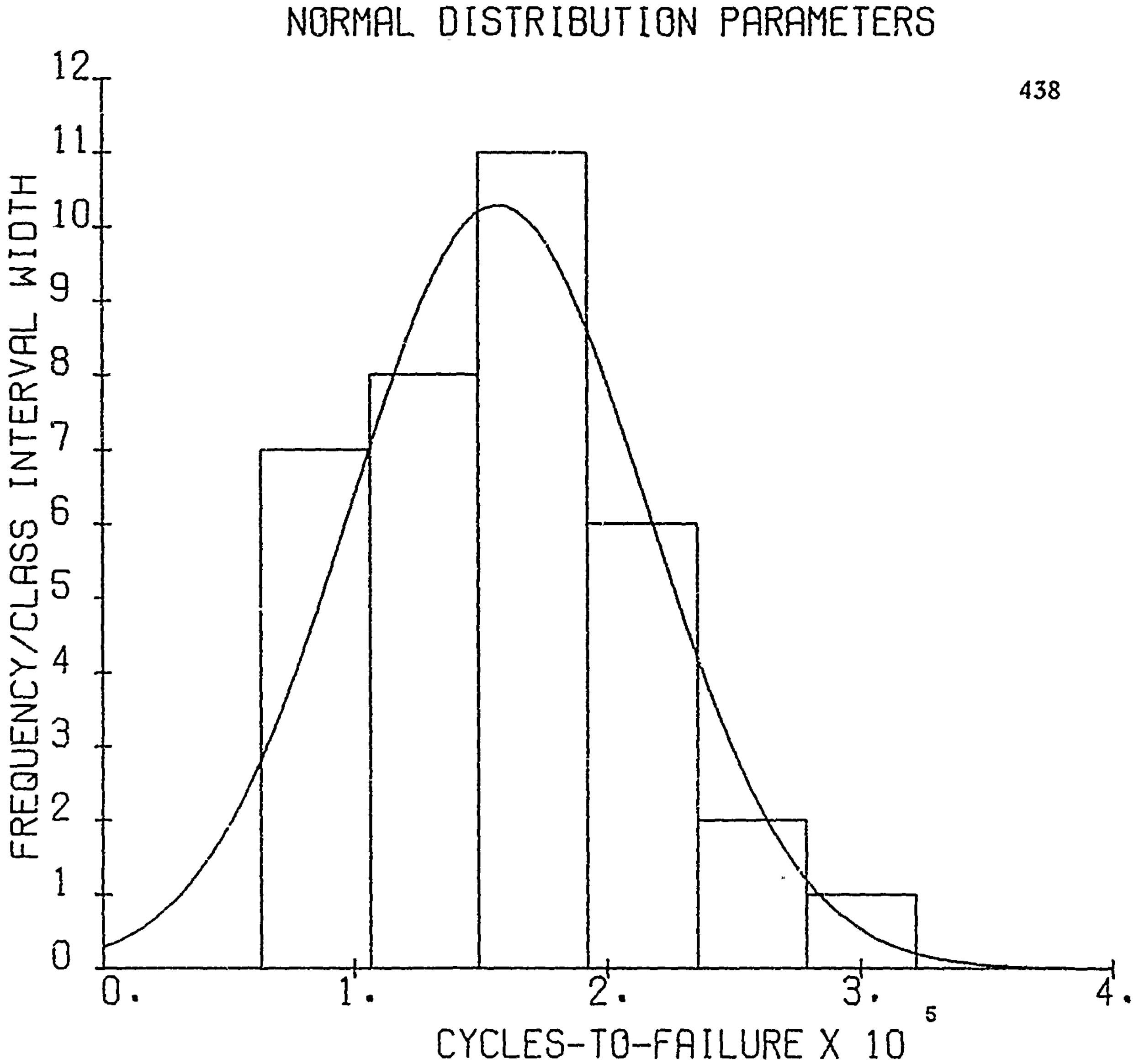
FIG. 9.1-47 CYCLES-TO-FAILURE DIST OF GROUP NO. 152 USING WIRE FATIGUE MACHINE NO. 4 FOR 35 SPECIMENS OF .040 IN. DIAMETER AISI 4340 STEEL WIRE. FIXED ALTERNATING STRESS LEVEL OF 80,100 PSI. BEND ANGLE 22.0 DEGREES. COAST-DOWN CYCLES 100.

WEIBULL DISTRIBUTION PARAMETERS



KOLMOGOROV-SMIRNOV TEST: 0.328
CHI-SQUARED TEST: 69.373
WEIBULL SLOPE (BETA): 0.559
MINIMUM LIFE (GAMMA): 79899
SCALE PARAMETER (ETA): 429256

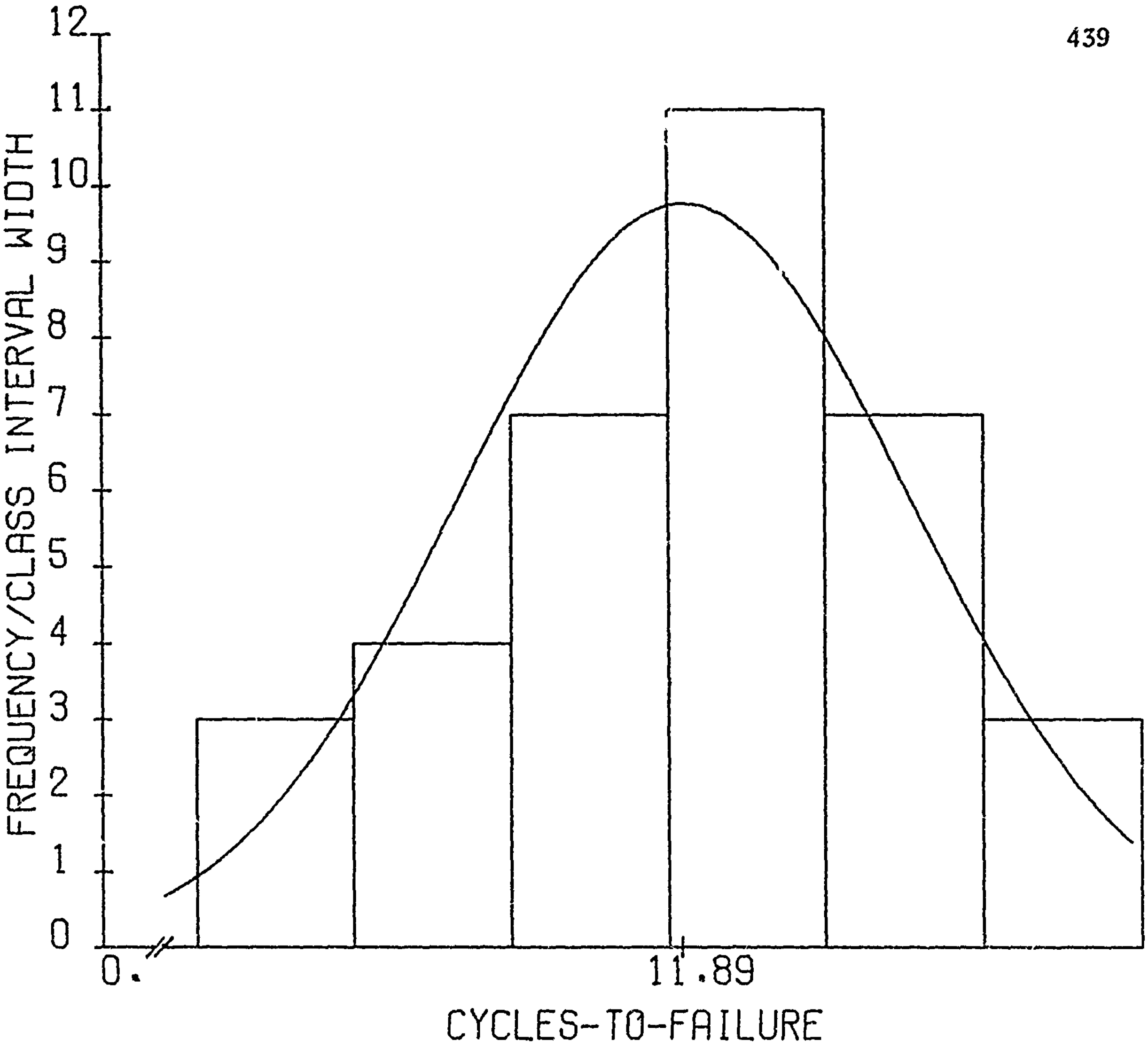
FIG. 9.1-48 CYCLES-TO-FAILURE DISTRIBUTION
GROUP=152
SL=80000 PSI



MEAN VALUE: 157314.3 CYCLES
STANDARD DEVIATION: 58475.9 CYCLES
KOLMOGOROV-SMIRNOV TEST: 0.081
CHI-SQUARED TEST: 0.288
SKEWNESS: 0.585
KURTOSIS: 3.241

FIG. 9-1-49 CYCLES-TO-FAILURE DIST OF GROUP NO. 153 USING WIRE FATIGUE MACHINE NO. 4 FOR 35 SPECIMENS OF .040 IN. DIAMETER AISI 4340 STEEL WIRE. FIXED ALTERNATING STRESS LEVEL OF 84,700 PSI. BEND ANGLE 23.0 DEGREES. COAST-DOWN CYCLES 100.

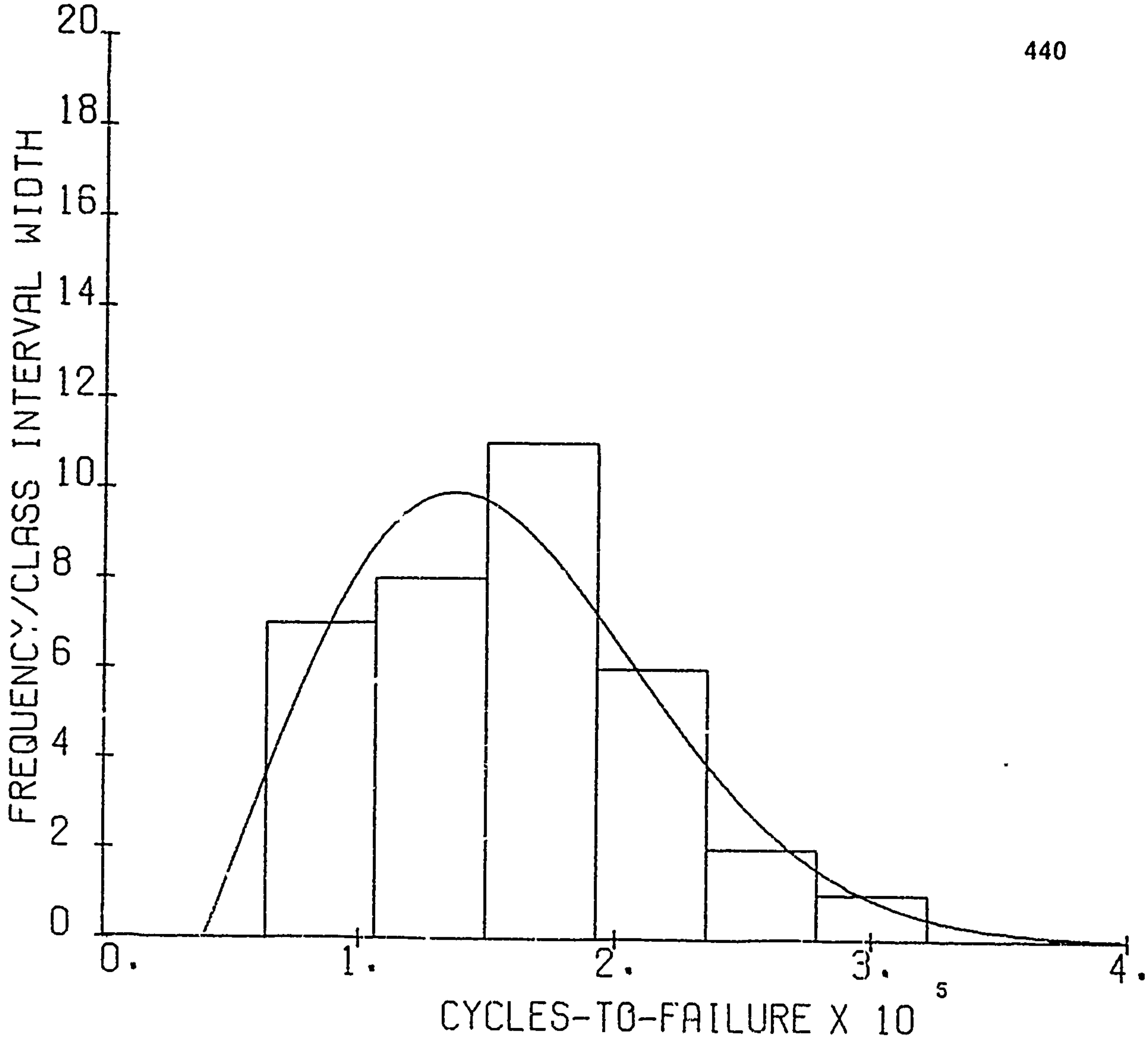
LOG NORMAL DISTRIBUTION PARAMETERS



MEAN VALUE:	11.896 CYCLES
STANDARD DEVIATION:	0.388 CYCLES
KOLMOGOROV-SMIRNOV TEST:	0.067
CHI-SQUARED TEST:	0.824
SKEWNESS:	-0.330
KURTOSIS:	2.643

FIG. 9.1-50 CYCLES-TO-FAILURE DIST OF GROUP NO. 153 USING WIRE FATIGUE MACHINE NO. 4 FOR 35 SPECIMENS OF .040 IN. DIAMETER AISI 4340 STEEL WIRE. FIXED ALTERNATING STRESS LEVEL OF 84,700 PSI. BEND ANGLE 23.0 DEGREES. COAST-DOWN CYCLES 100.

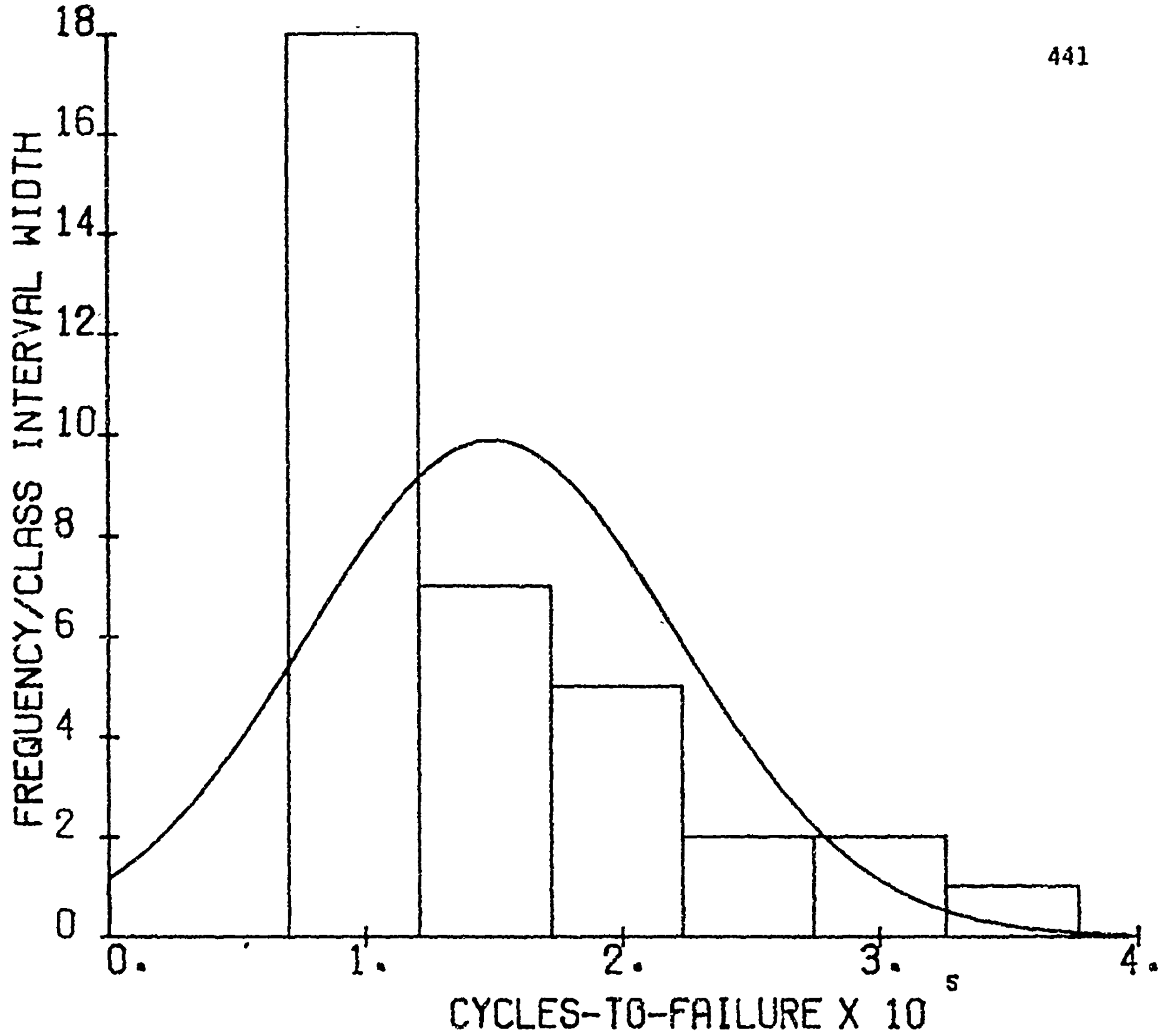
WEIBULL DISTRIBUTION PARAMETERS



KOLMOGOROV-SMIRNOV TEST: 0.059
CHI-SQUARED TEST: 1.227
WEIBULL SLOPE (BETA): 2.081
MINIMUM LIFE (GAMMA): 39099
SCALE PARAMETER (ETA): 134262

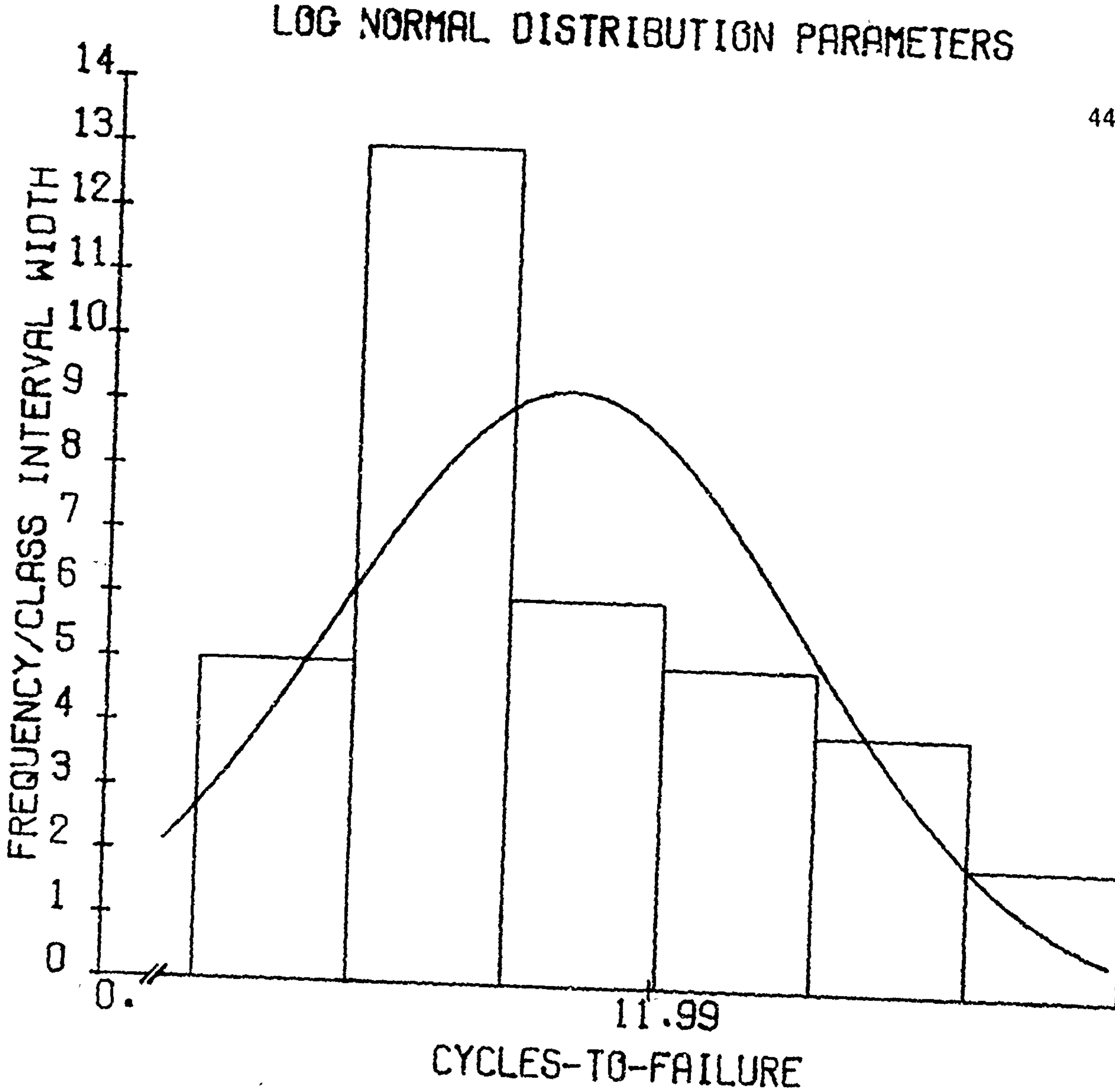
FIG. 9.1-51 CYCLES-TO-FAILURE DISTRIBUTION
SL=84700
GROUP=153

NORMAL DISTRIBUTION PARAMETERS



MEAN VALUE:	149548.6	CYCLES
STANDARD DEVIATION:	72183.9	CYCLES
KOLMOGOROV-SMIRNOV TEST:	0.169	
CHI-SQUARED TEST:	4.601	
SKEWNESS:	1.440	
KURTOSIS:	4.638	

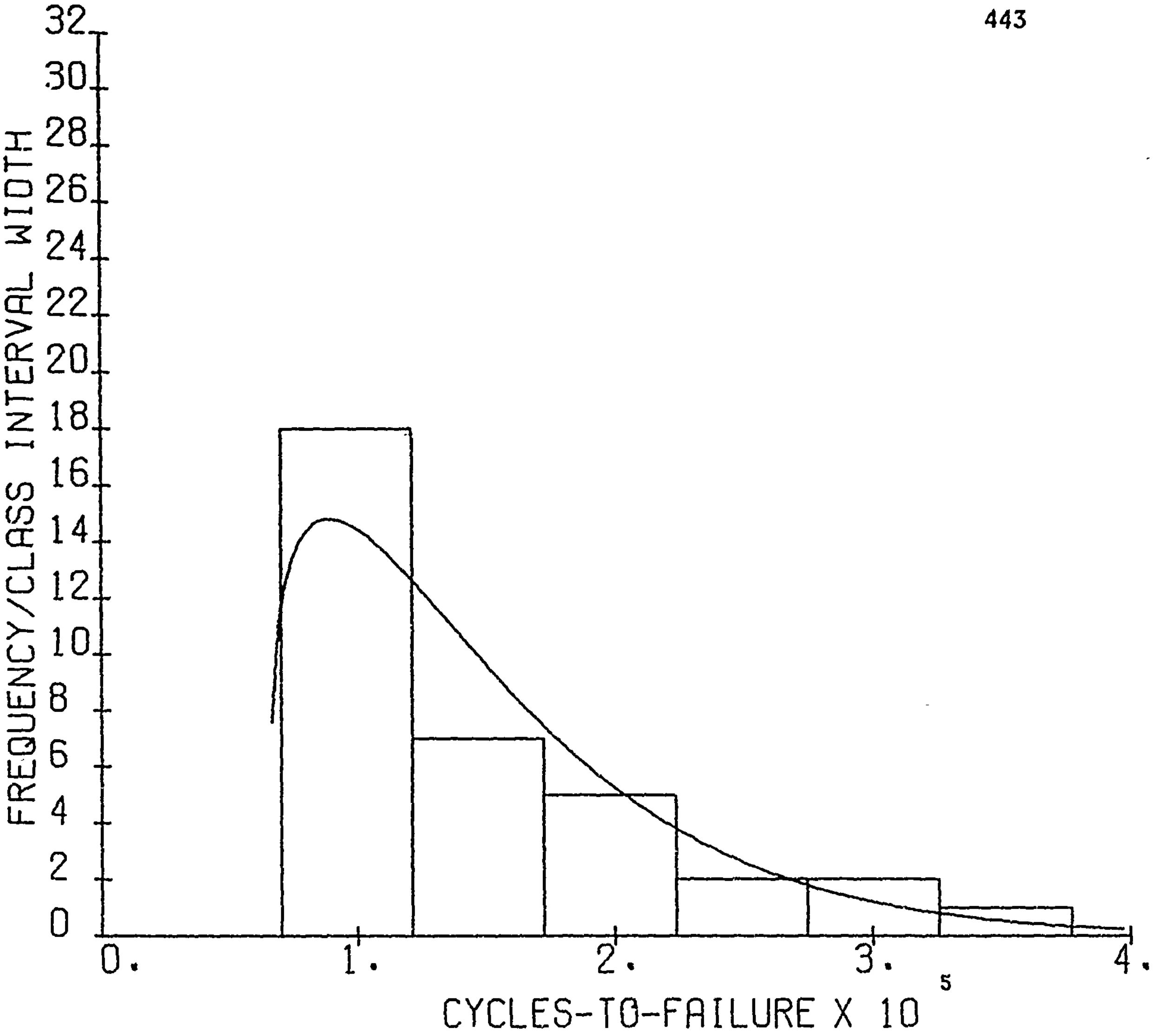
FIG. 9.1-52 CYCLES-TO-FAILURE DIST OF GROUP NO. 154 USING WIRE FATIGUE MACHINE NO. 4 FOR 35 SPECIMENS OF .040 IN. DIAMETER AISI 4340 STEEL WIRE. FIXED ALTERNATING STRESS LEVEL OF 90,000 PSI. BEND ANGLE 24.0 DEGREES. COAST-DOWN CYCLES 100.



MEAN VALUE:	11.822	CYCLES
STANDARD DEVIATION:	0.423	CYCLES
KOLMOGOROV-SMIRNOV TEST:	0.133	
CHI-SQUARED TEST:	5.678	
SKEWNESS:	0.632	
KURTOSIS:	2.607	

FIG. 9.1-53 CYCLES-TO-FAILURE DIST OF GROUP NO. 154 USING WIRE FATIGUE MACHINE NO. 4 FOR 35 SPECIMENS OF .040 IN. DIAMETER AISI 4340 STEEL WIRE. FIXED ALTERNATING STRESS LEVEL OF 90,000 PSI. BEND ANGLE 24.0 DEGREES. COAST-DOWN CYCLES 100.

WEIBULL DISTRIBUTION PARAMETERS



KOLMOGOROV-SMIRNOV TEST: 0.102

CHI-SQUARED TEST: 7.581

WEIBULL SLOPE (BETA): 1.231

MINIMUM LIFE (GAMMA): 66100

SCALE PARAMETER (ETA): 90019

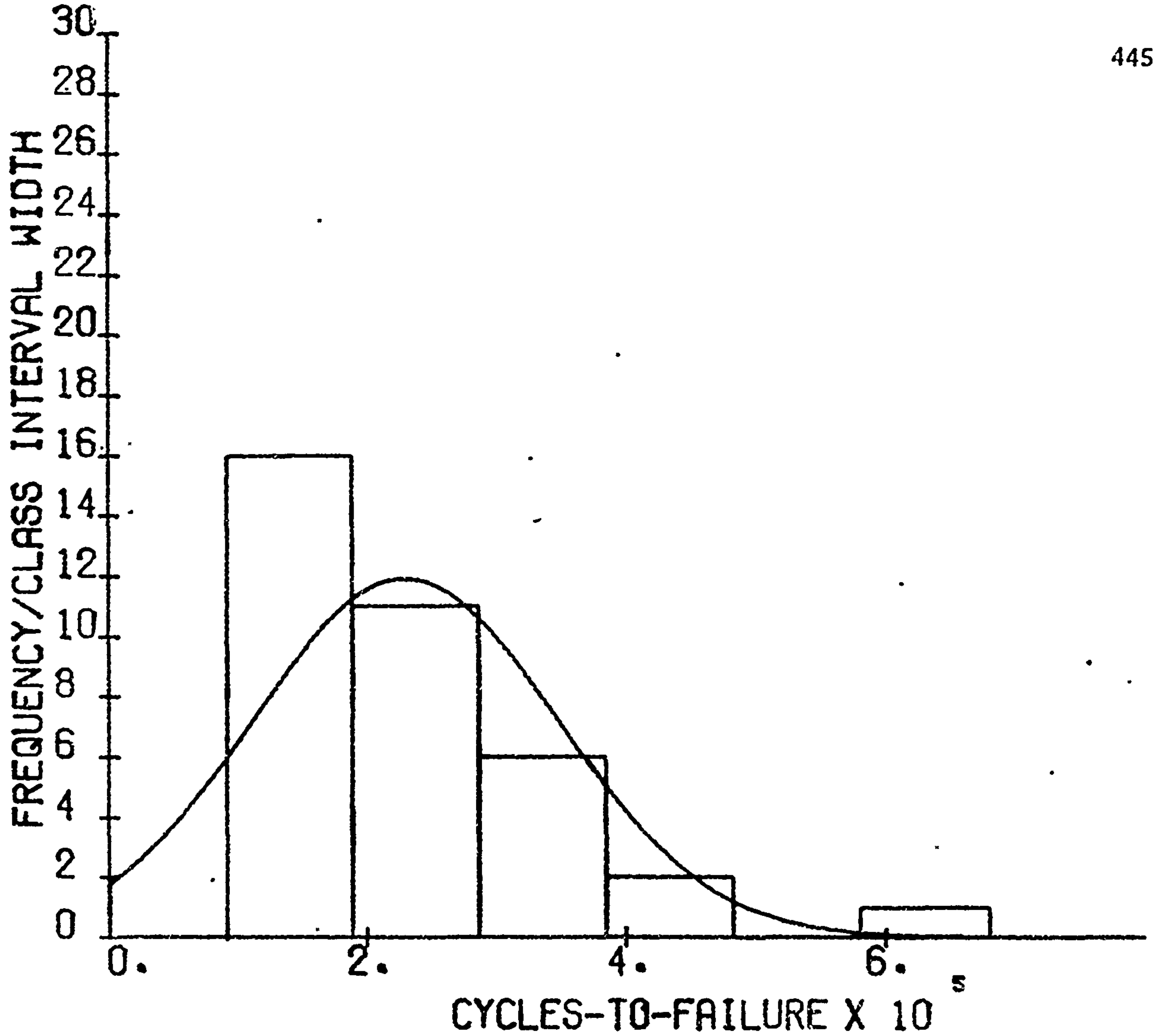
FIG. 9.1-54 CYCLES-TO-FAILURE DISTRIBUTION

SL=90000 PSI

GROUP=154

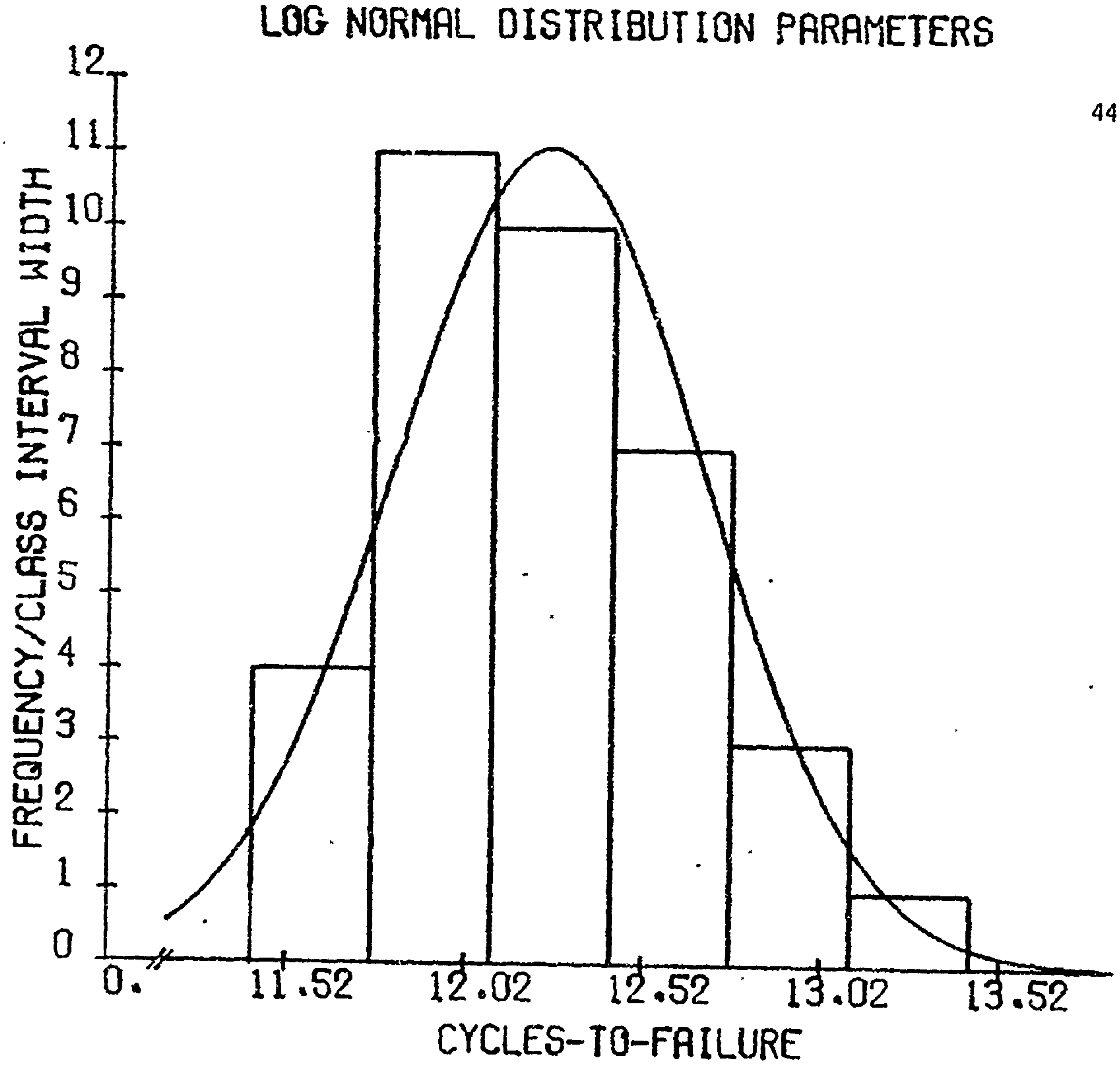
9.2 WIEDEMANN FATIGUE MACHINE DATA

NORMAL DISTRIBUTION PARAMETERS



MEAN VALUE:	229777.8 CYCLES
STANDARD DEVIATION:	118013.8 CYCLES
KOLMOGOROV-SMIRNOV TEST:	0.183
CHI-SQUARED TEST:	1.169
SKEWNESS:	1.900
KURTOSIS:	7.284

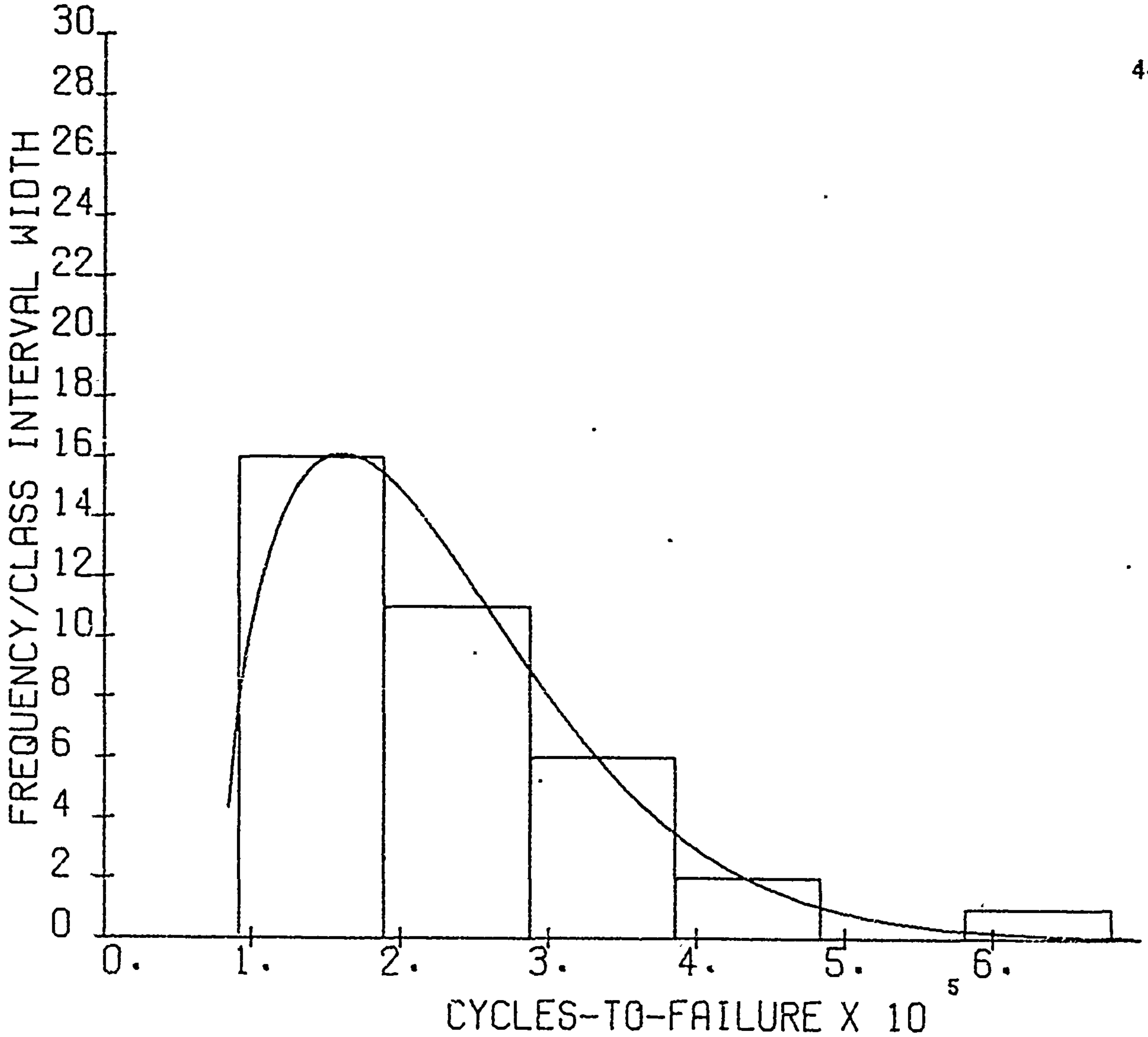
FIG. 9.2-1 CYCLES-TO-FAILURE DIST OF GROUP NO. 89 USING THE WEIDEMANN FATIGUE MACHINE FOR 36 SPECIMENS OF .0937 IN. NOTCH DIAMETER AND .125 IN. NOTCH RADIUS AISI 4130 STEEL ROD. FIXED ALTERNATING STRESS LEVEL OF 75000 PSI.



MEAN VALUE:	12.245 CYCLES
STANDARD DEVIATION:	0.434 CYCLES
KOLMOGOROV-SMIRNOV TEST:	0.095
CHI-SQUARED TEST:	0.508
SKEWNESS:	0.628
KURTOSIS:	3.155

FIG. 9.2-2 CYCLES-TO-FAILURE DIST OF GROUP NO. 89 USING THE WEIDEMANN FATIGUE MACHINE FOR 36 SPECIMENS OF .0937 IN. NOTCH DIAMETER AND .125 IN. NOTCH RADIUS AISI 4130 STEEL ROD. FIXED ALTERNATING STRESS LEVEL OF 75000 PSI.

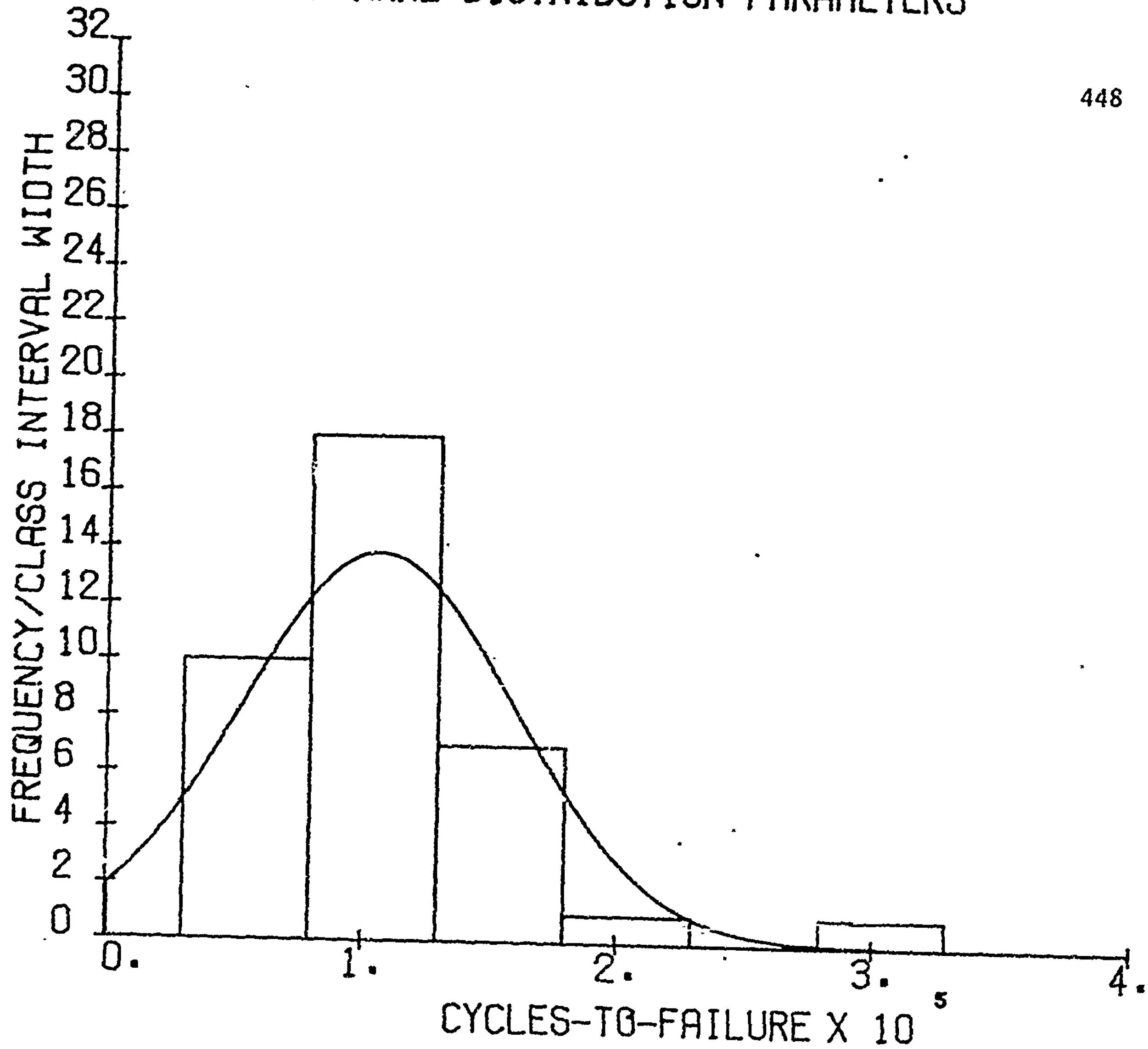
WEIBULL DISTRIBUTION PARAMETERS



KOLMOGOROV-SMIRNOV TEST: 0.106
CHI-SQUARED TEST: 4.389
WEIBULL SLOPE (BETA): 1.513
MINIMUM LIFE (GAMMA): 80800
SCALE PARAMETER (ETA): 164090

FIG. 9.2-3 CYCLES-TO-FAILURE DISTRIBUTION
SL=75000
GROUP=89

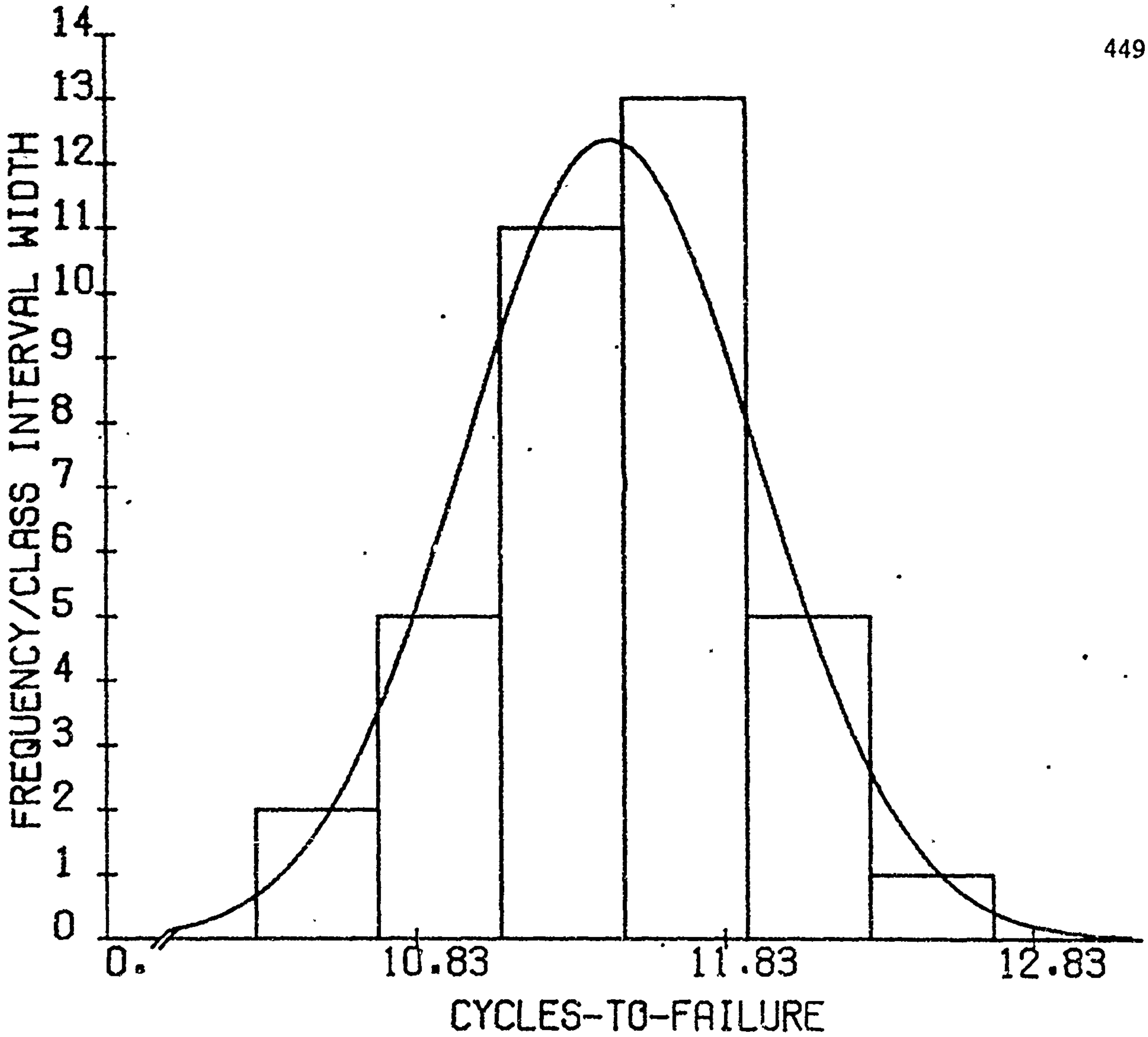
NORMAL DISTRIBUTION PARAMETERS



MEAN VALUE:	105837.8 CYCLES
STANDARD DEVIATION:	53222.0 CYCLES
KOLMOGOROV-SMIRNOV TEST:	0.143
CHI-SQUARED TEST:	2.610
SKEWNESS:	1.944
KURTOSIS:	9.326

FIG. 9.2-4 CYCLES-TO-FAILURE DIST OF GROUP NO. 90 USING THE WIEDEMANN FATIGUE MACHINE FOR 37 SPECIMENS OF .0937 IN. NOTCH DIAMETER AND .125 IN. NOTCH RADIUS AISI 4130 STEEL ROD. FIXED ALTERNATING STRESS LEVEL OF 85000 PSI.

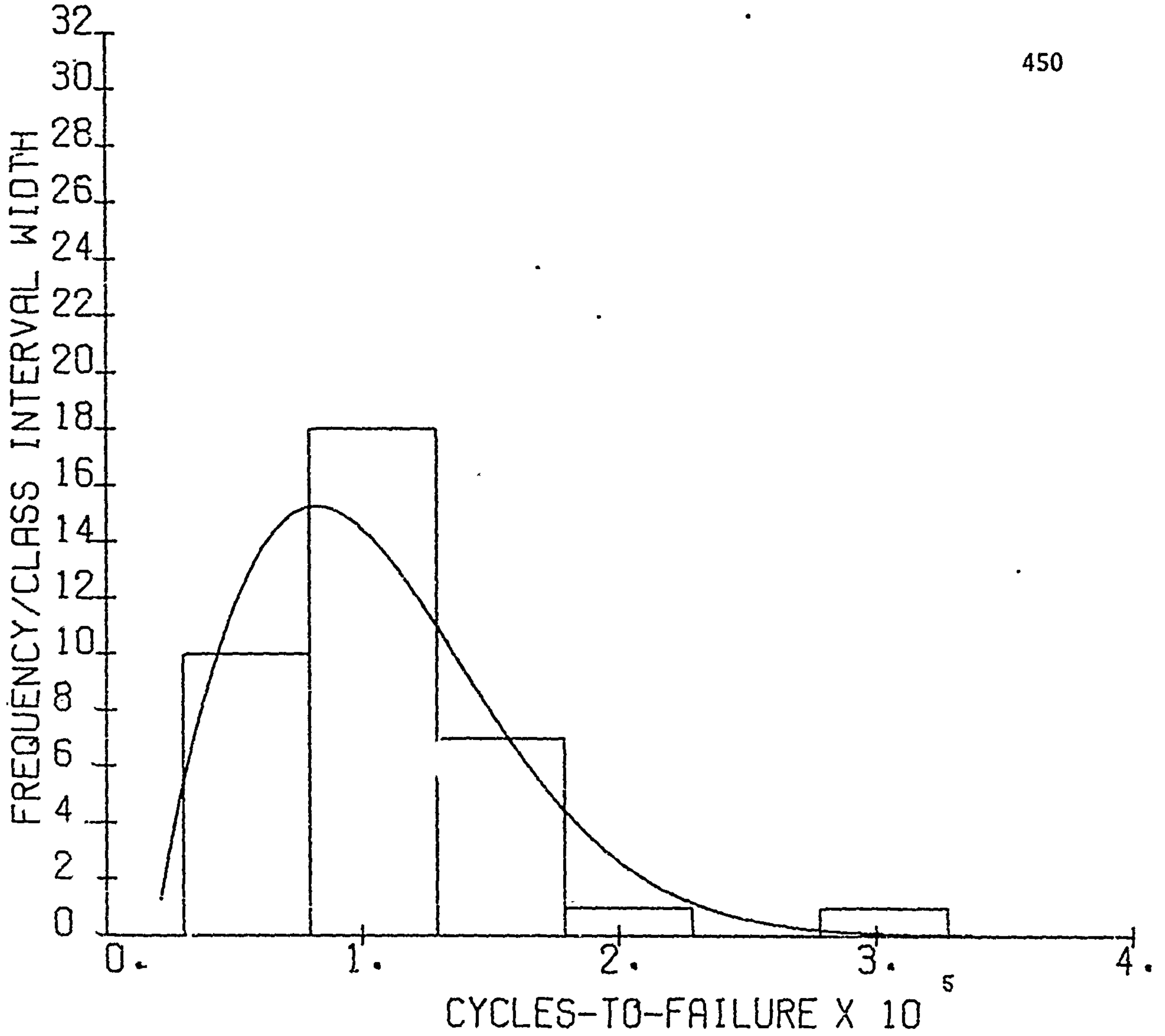
LOG NORMAL DISTRIBUTION PARAMETERS



MEAN VALUE:	11.461	CYCLES
STANDARD DEVIATION:	0.476	CYCLES
KOLMOGOROV-SMIRNOV TEST:	0.086	
CHI-SQUARED TEST:	0.832	
SKEWNESS:	-0.175	
KURTOSIS:	3.401	

FIG. 9.2-5 CYCLES-TO-FAILURE DIST OF GROUP NO. 90 USING THE WIEDEMANN FATIGUE MACHINE FOR 37 SPECIMENS OF .0937 IN. NOTCH DIAMETER AND .125 IN. NOTCH RADIUS AISI 4130 STEEL ROD. FIXED ALTERNATING STRESS LEVEL OF 85000 PSI.

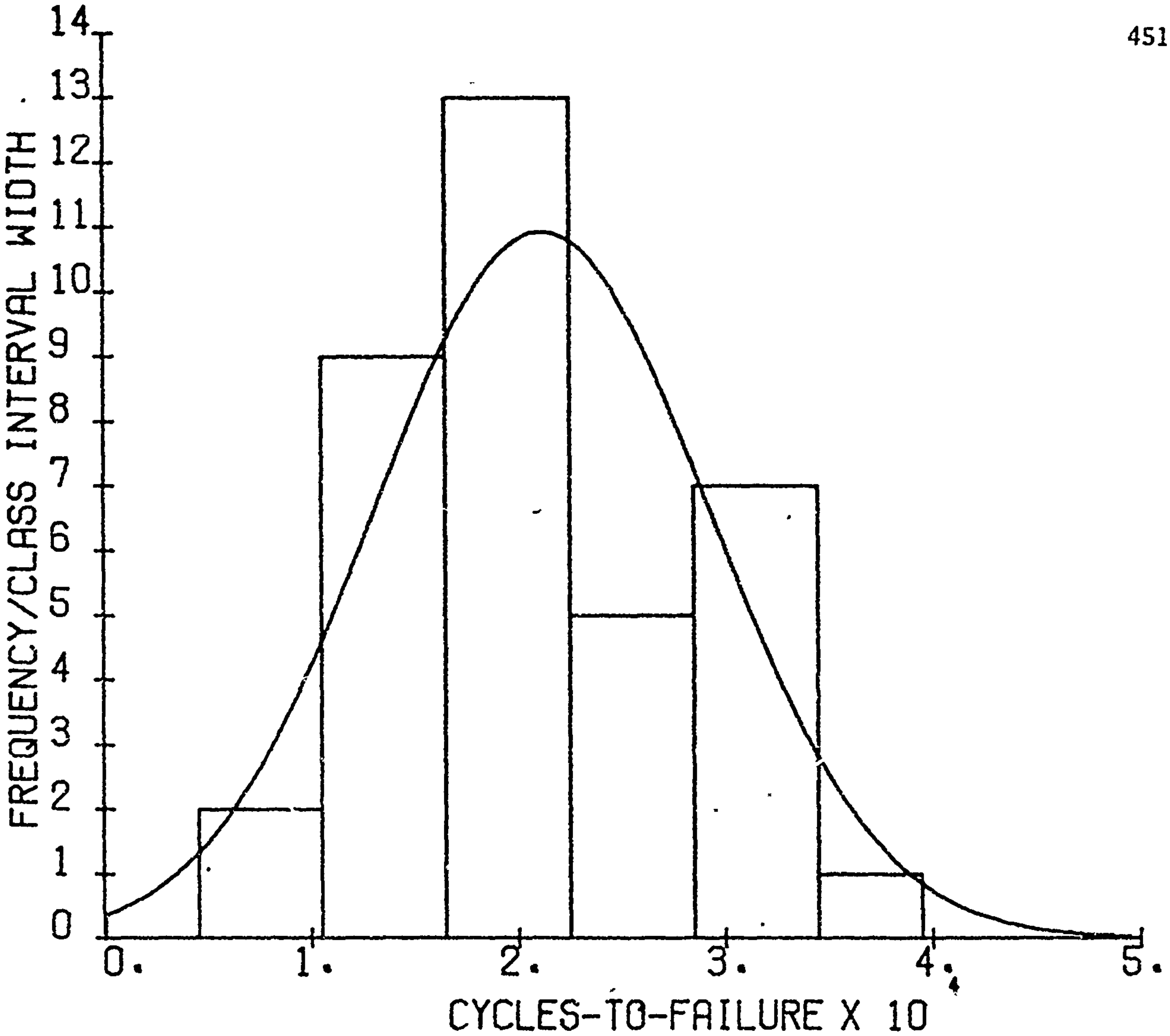
WEIBULL DISTRIBUTION PARAMETERS



KOLMOGOROV-SMIRNOV TEST: 0.107
CHI-SQUARED TEST: 8.507
WEIBULL SLOPE (BETA): 1.825
MINIMUM LIFE (GAMMA): 19500
SCALE PARAMETER (ETA): 97719

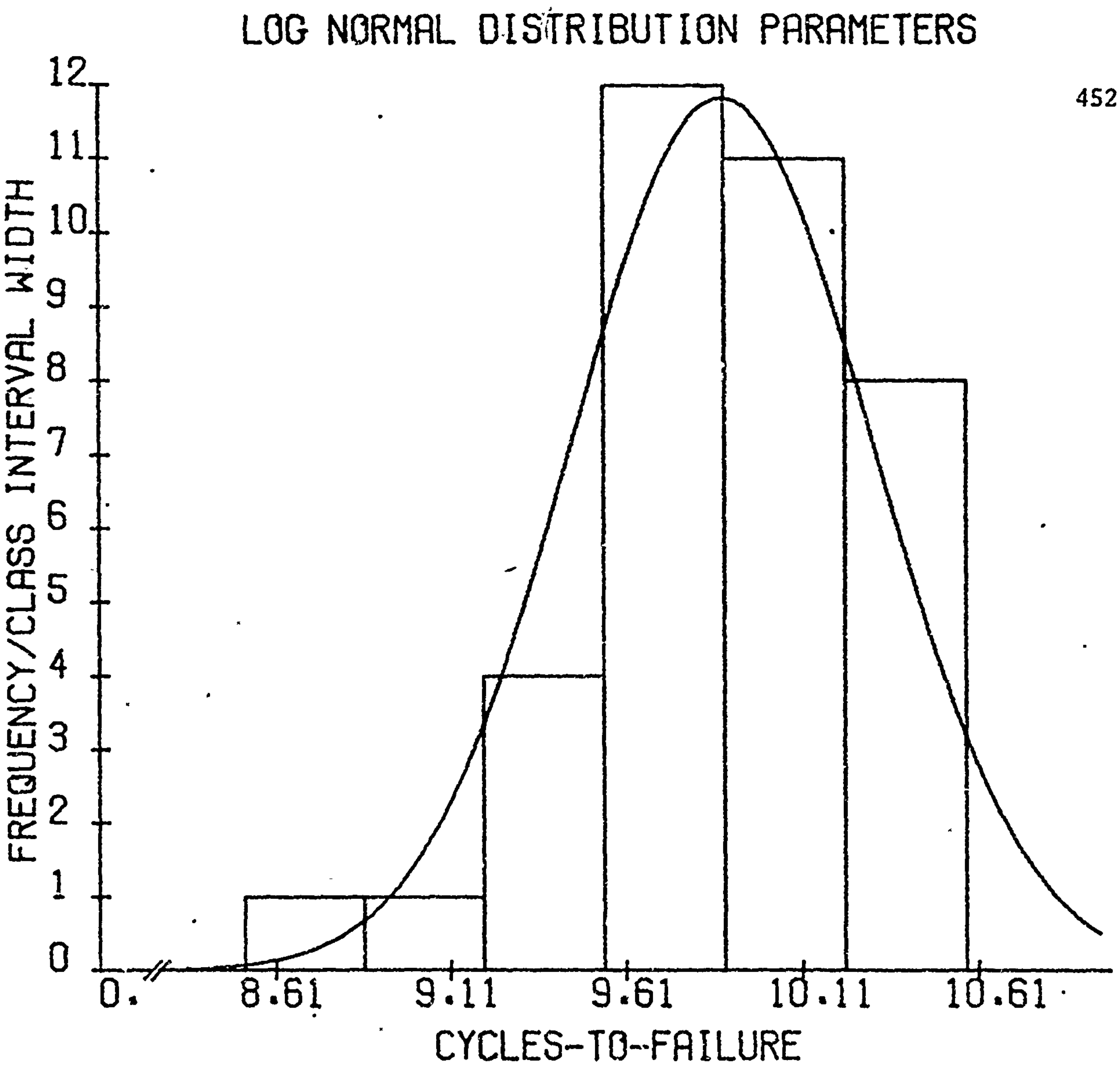
FIG. 9.2-6 CYCLES-TO-FAILURE DISTRIBUTION
SL=85000 PSI
GROUP=90

NORMAL DISTRIBUTION PARAMETERS



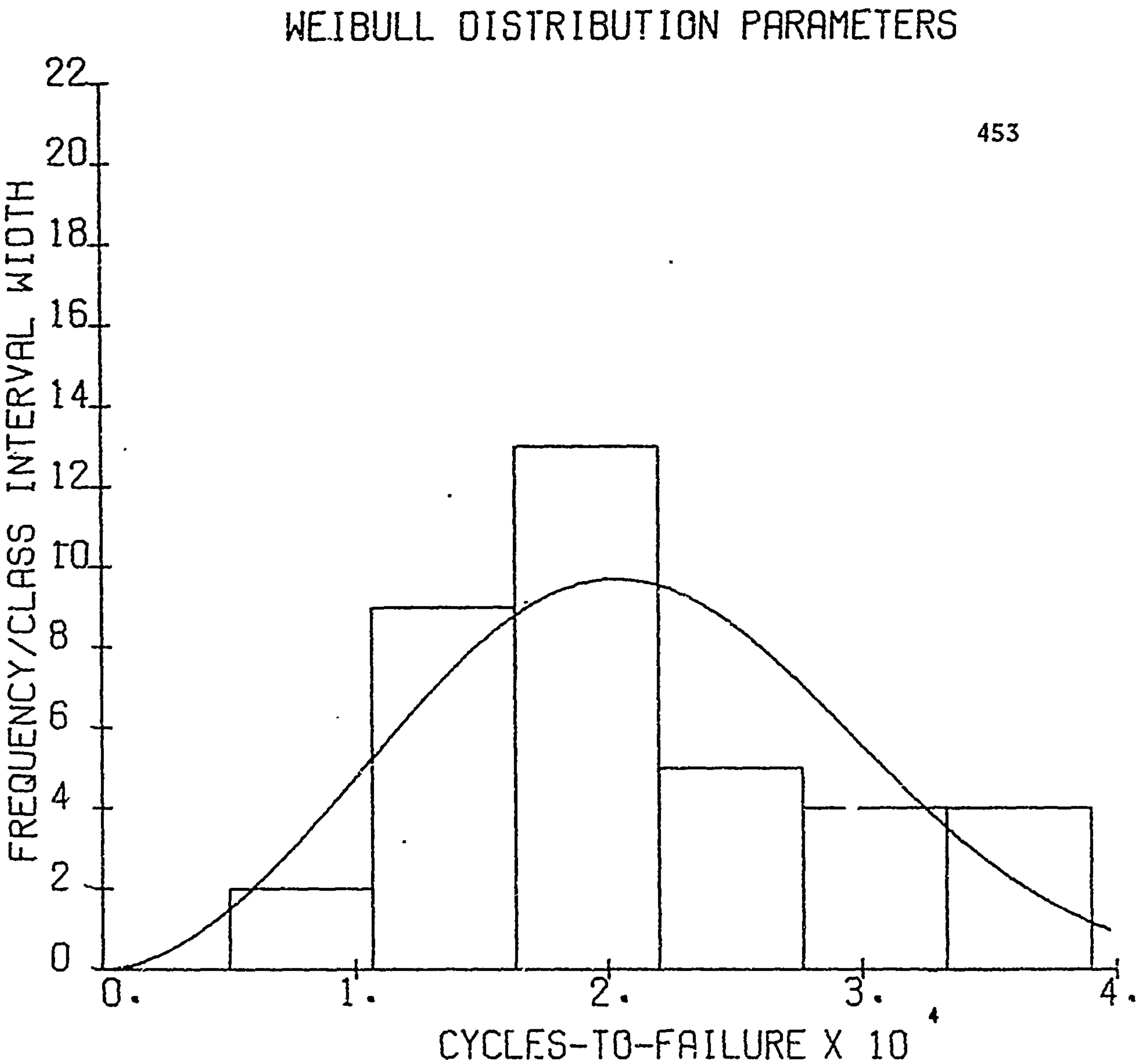
MEAN VALUE:	21162.2 CYCLES
STANDARD DEVIATION:	8095.0 CYCLES
KOLMOGOROV-SMIRNOV TEST:	0.138
CHI-SQUARED TEST:	2.873
SKEWNESS:	0.374
KURTOSIS:	2.458

FIG. 9.2-7 CYCLES-TO-FAILURE DIST OF GROUP NO. 91 USING THE WEIDEMANN FATIGUE MACHINE FOR 37 SPECIMENS OF .0937 IN. NOTCH DIAMETER AND .125 IN. NOTCH RADIUS AISI 4130 STEEL ROD. FIXED ALTERNATING STRESS LEVEL OF 90000.



MEAN VALUE:	9.880	CYCLES
STANDARD DEVIATION:	0.427	CYCLES
KOLMOGOROV-SMIRNOV TEST:	0.077	
CHI-SQUARED TEST:	0.668	
SKEWNESS:	-0.831	
KURTOSIS:	4.341	

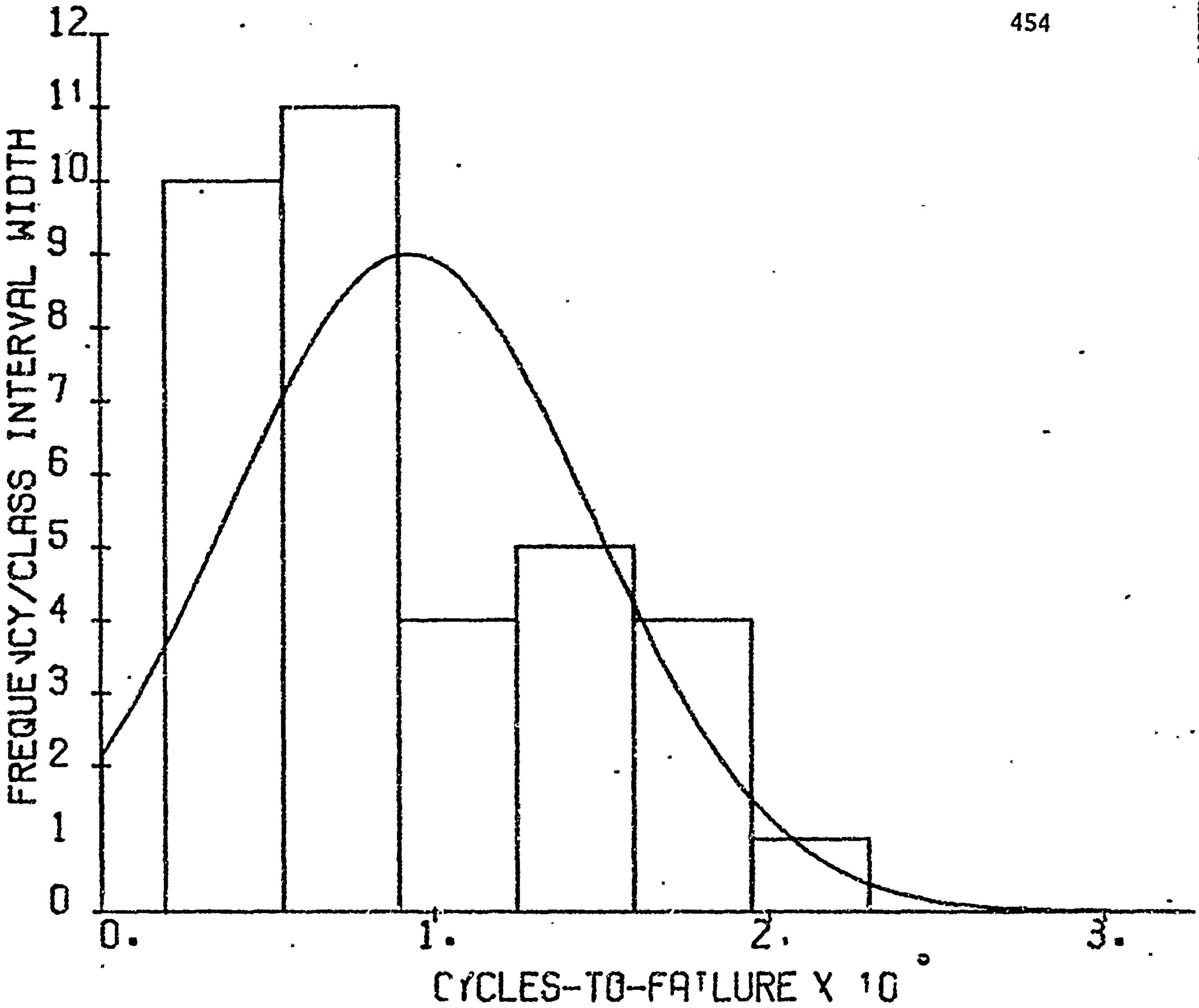
FIG. 9.2-8 CYCLES-TO-FAILURE DIST OF GROUP NO. 91 USING THE WEIDEMANN FATIGUE MACHINE FOR 37 SPECIMENS OF .0937 IN. NOTCH DIAMETER AND .125 IN. NOTCH RADIUS AISI 4130 STEEL ROD. FIXED ALTERNATING STRESS LEVEL OF 90000.



KOLMOGOROV-SMIRNOV TEST: 0.120
CHI-SQUARED TEST: 1.950
WEIBULL SLOPE (BETA): 2.786
MINIMUM LIFE (GAMMA): 0
SCALE PARAMETER (ETA): 23860

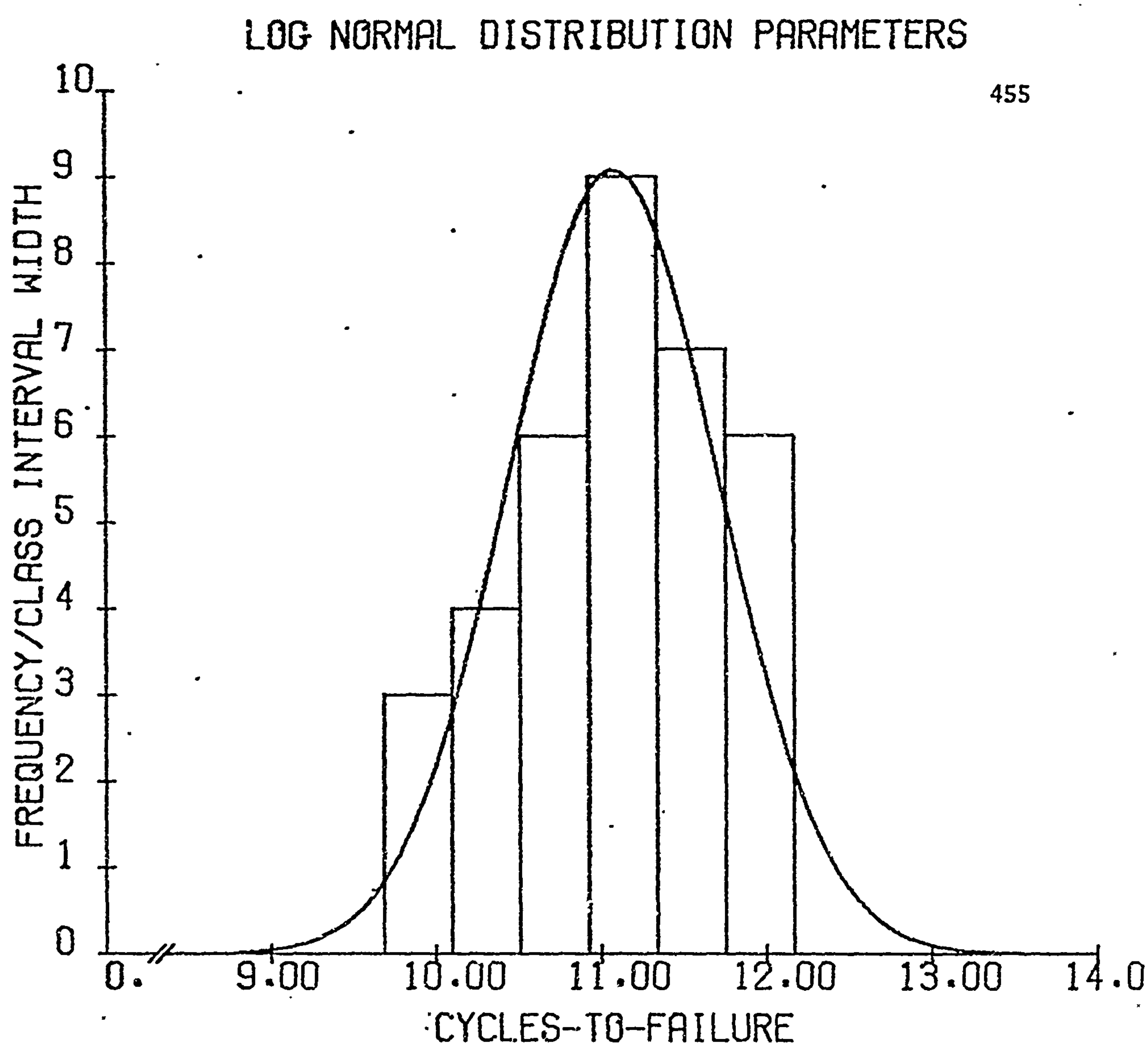
FIG. 9.2-9 CYCLES-TO-FAILURE DISTRIBUTION
SL=95000 PSI
GROUP=91

NORMAL DISTRIBUTION PARAMETERS



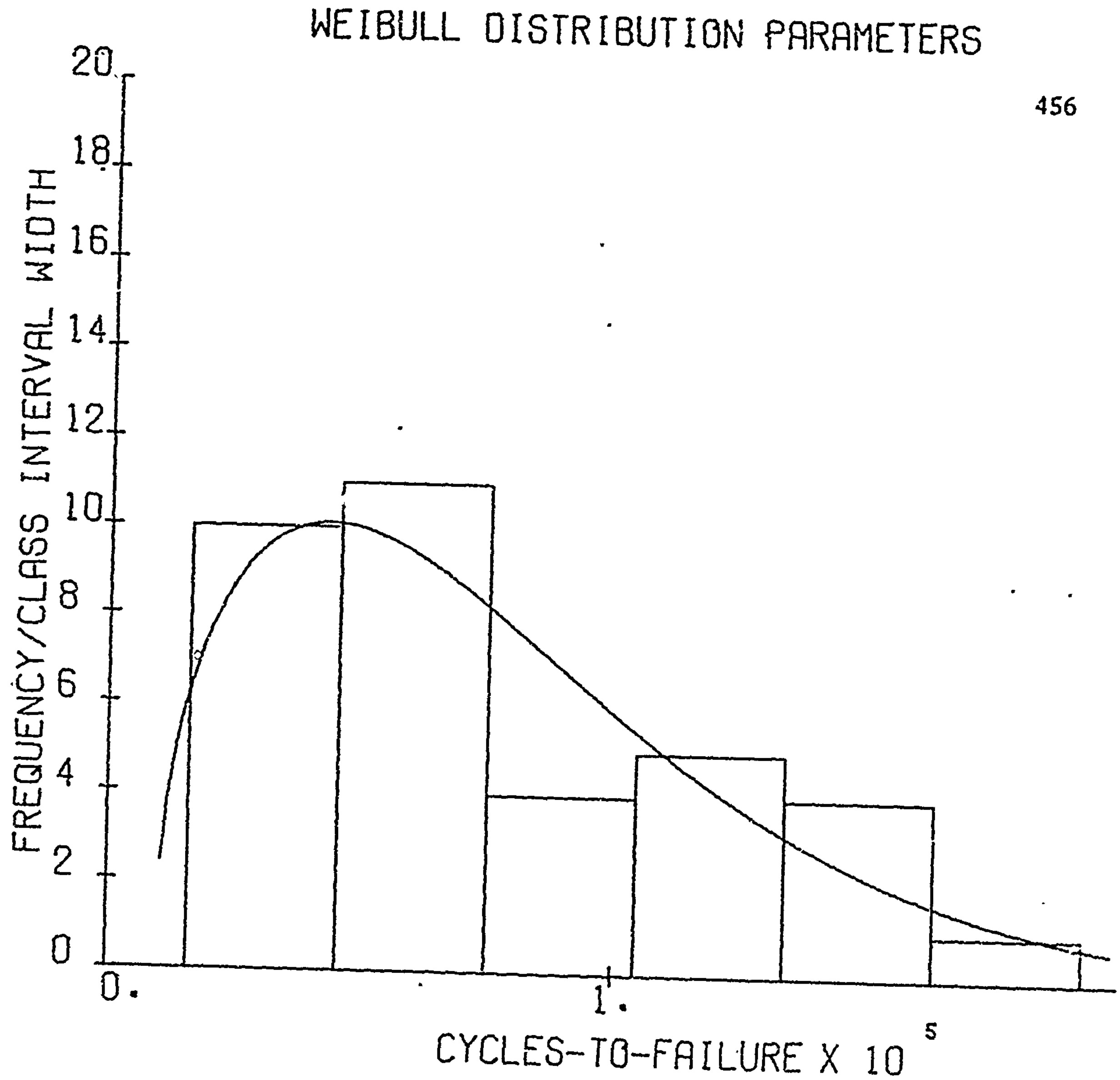
MEAN VALUE: 77600.0 CYCLES
STANDARD DEVIATION: 45797.6 CYCLES
KOLMOGOROV-SMIRNOV TEST: 0.192
CHI-SQUARED TEST: 4.128
SKEWNESS: 0.732
KURTOSIS: 2.601

FIG. 9.2-10 CYCLES-TO-FAILURE DIST OF CROUP NO. 93 USING THE WIEDEMANN FATIGUE MACHINE FOR 35 SPECIMENS OF .0937 IN. NOTCH DIAMETER AND .250 IN. NOTCH RADIUS AISI 4130 STEEL ROD. FIXED ALTERNATING STRESS LEVEL OF 70000 PSI.



MEAN VALUE:	11.077	CYCLES
STANDARD DEVIATION:	0.639	CYCLES
KOLMOGOROV-SMIRNOV TEST:	0.078	
CHI-SQUARED TEST:	0.574	
SKEWNESS:	-0.307	
KURTOSIS:	2.438	

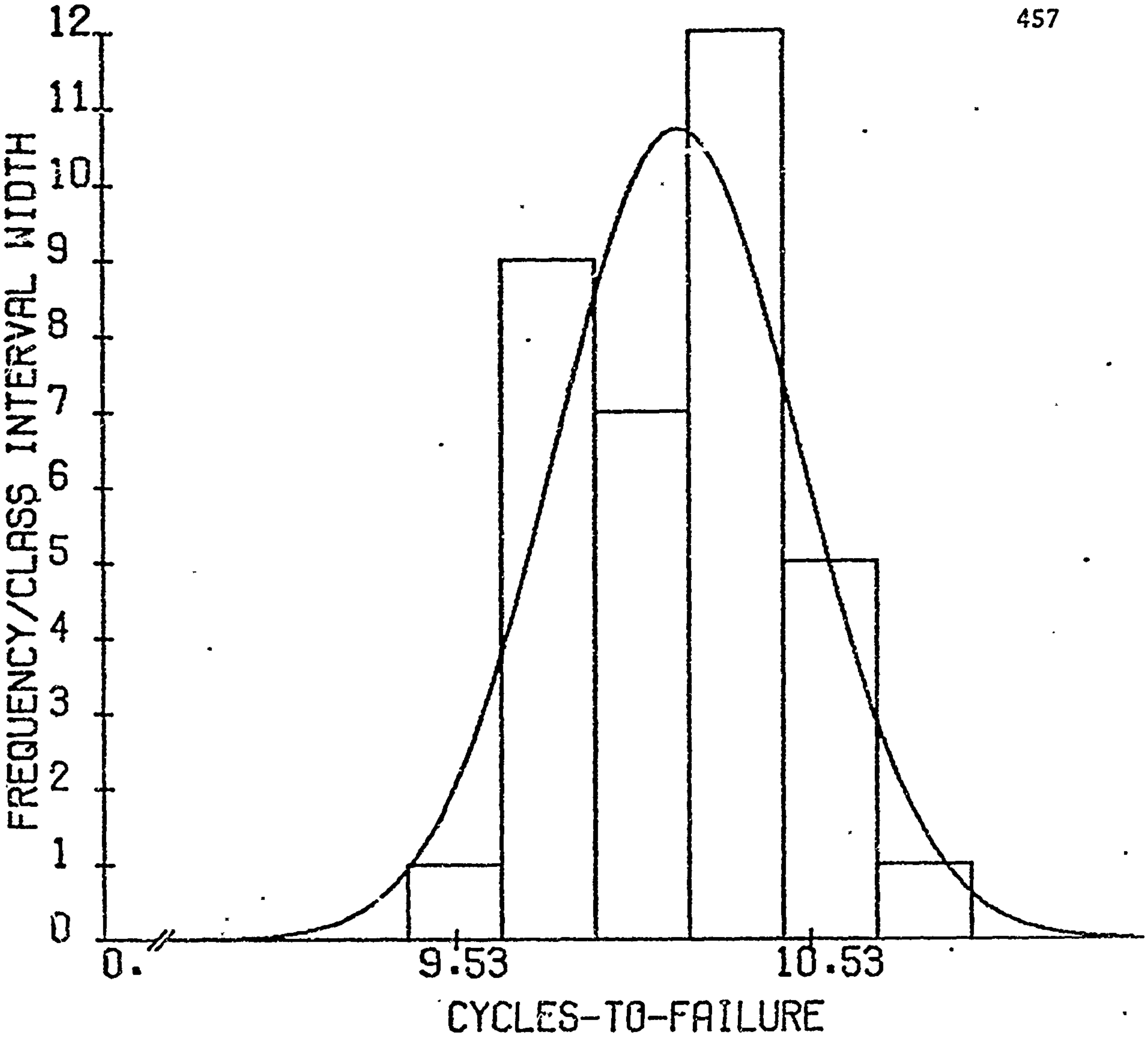
FIG. 9.2-11 CYCLES-TO-FAILURE DIST OF GROUP NO. 9 USING THE WIEDEMANN FATIGUE MACHINE FOR 35 SPECIMENS OF .0937 IN. NOTCH DIAMETER AND .250 IN. NOTCH RADIUS AIS 4130 STEEL ROD. FIXED ALTERNATING STRESS LEVEL OF 70000 PSI.



KOLMOGOROV-SMIRNOV TEST: 0.114
CHI-SQUARED TEST: 6.484
WEIBULL SLOPE (BETA): 1.444
MINIMUM LIFE (GAMMA): 10000
SCALE PARAMETER (ETA): 75545

FIG. 9.2-12 CYCLES-TO-FAILURE DISTRIBUTION
SL=70000 PSI
GROUP=93

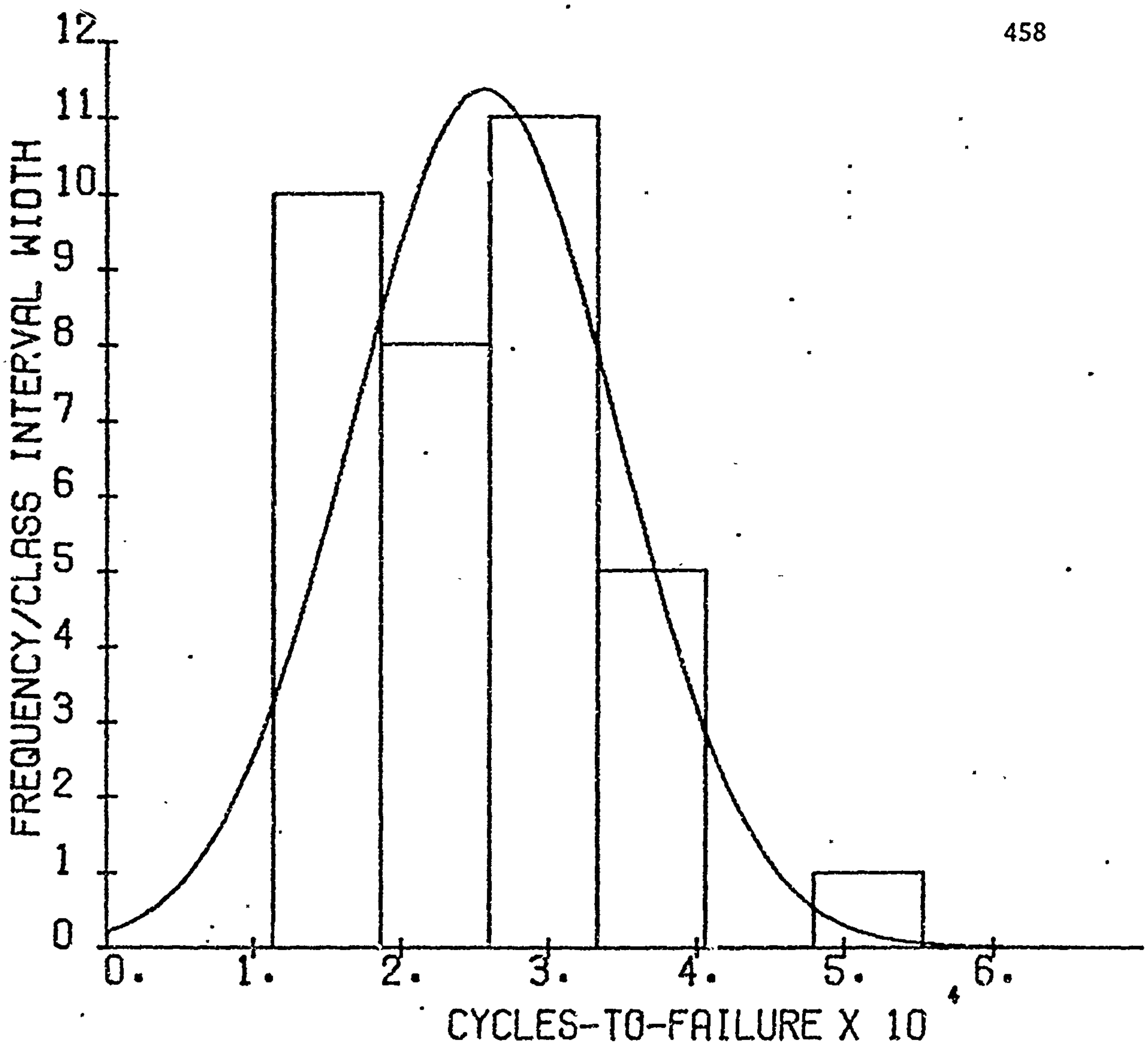
LOG NORMAL DISTRIBUTION PARAMETERS



MEAN VALUE:	10.157 CYCLES
STANDARD DEVIATION:	0.346 CYCLES
KOLMOGOROV-SMIRNOV TEST:	0.097
CHI-SQUARED TEST:	1.931
SKEWNESS:	-0.012
KURTOSIS:	2.691

FIG. 9.2-13 CYCLES-TO-FAILURE DIST OF GROUP NO. 94 USING THE WIEDEMANN FATIGUE MACHINE FOR 35 SPECIMENS OF .0937 IN. NOTCH DIAMETER AND .250 IN. NOTCH RADIUS AISI 4130 STEEL ROD. FIXED ALTERNATING STRESS LEVEL OF 80000 PSI.

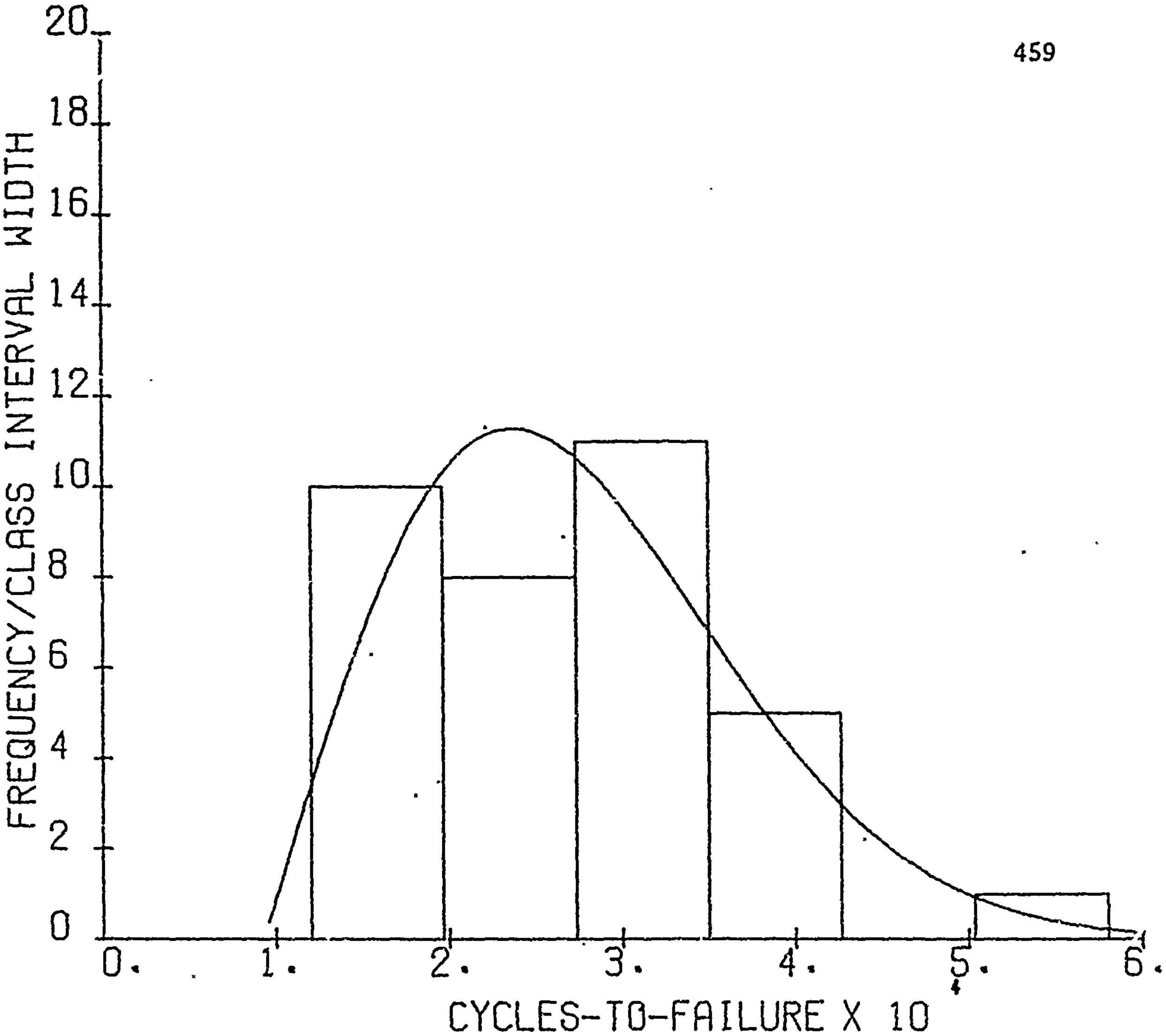
NORMAL DISTRIBUTION PARAMETERS



MEAN VALUE:	27314.3 CYCLES
STANDARD DEVIATION:	9627.7 CYCLES
KOLMOGOROV-SMIRNOV TEST:	0.113
CHI-SQUARED TEST:	1.466
SKEWNESS:	0.978
KURTOSIS:	4.546

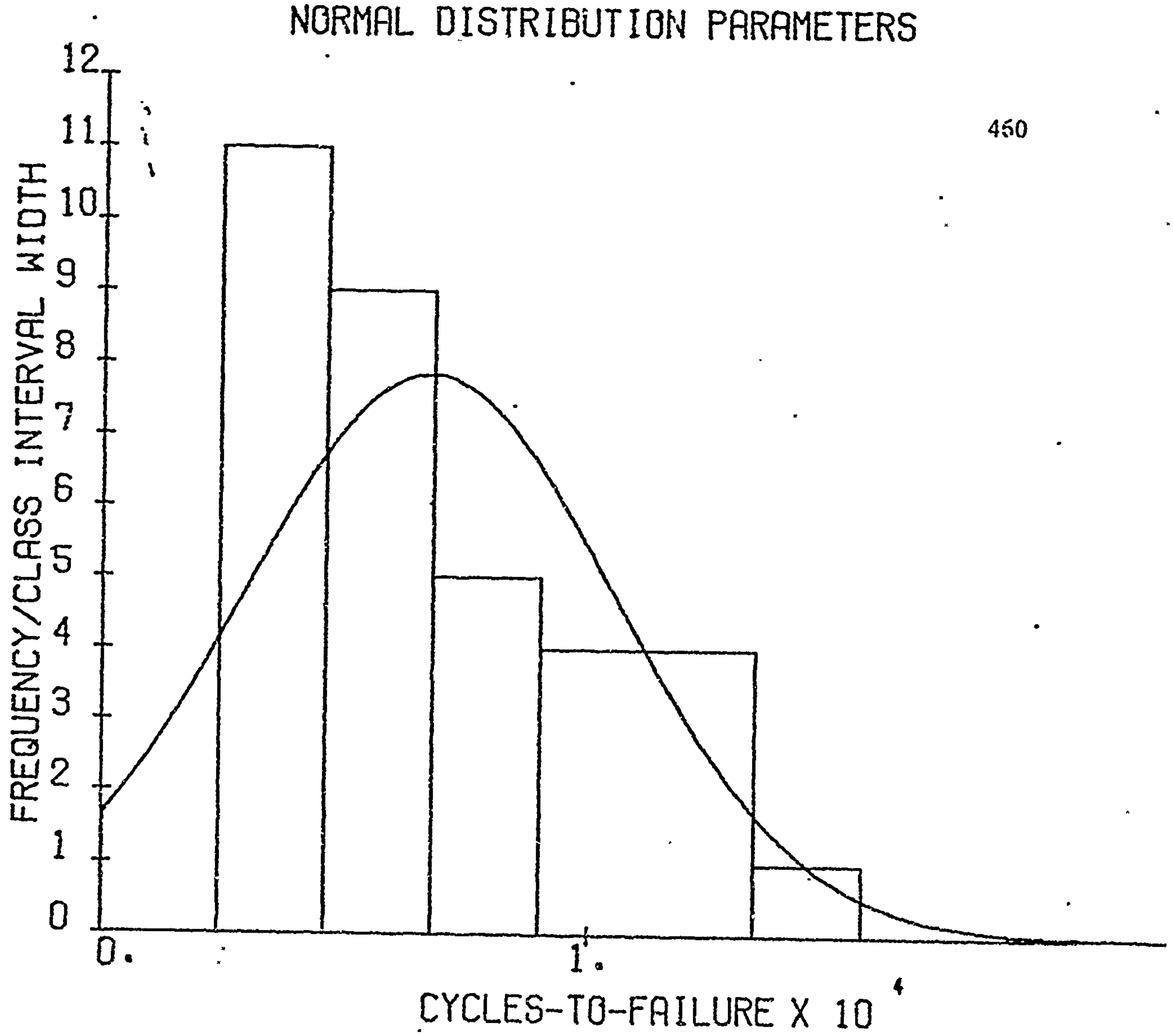
FIG. 9.2-14 CYCLES-TO-FAILURE DIST OF GROUP NO. 94 USING THE WIEDEMANN FATIGUE MACHINE FOR 35 SPECIMENS OF .0937 IN. NOTCH DIAMETER AND .250 IN. NOTCH RADIUS AISI 4130 STEEL ROD. FIXED ALTERNATING STRESS LEVEL OF 80000 PSI.

WEIBULL DISTRIBUTION PARAMETERS



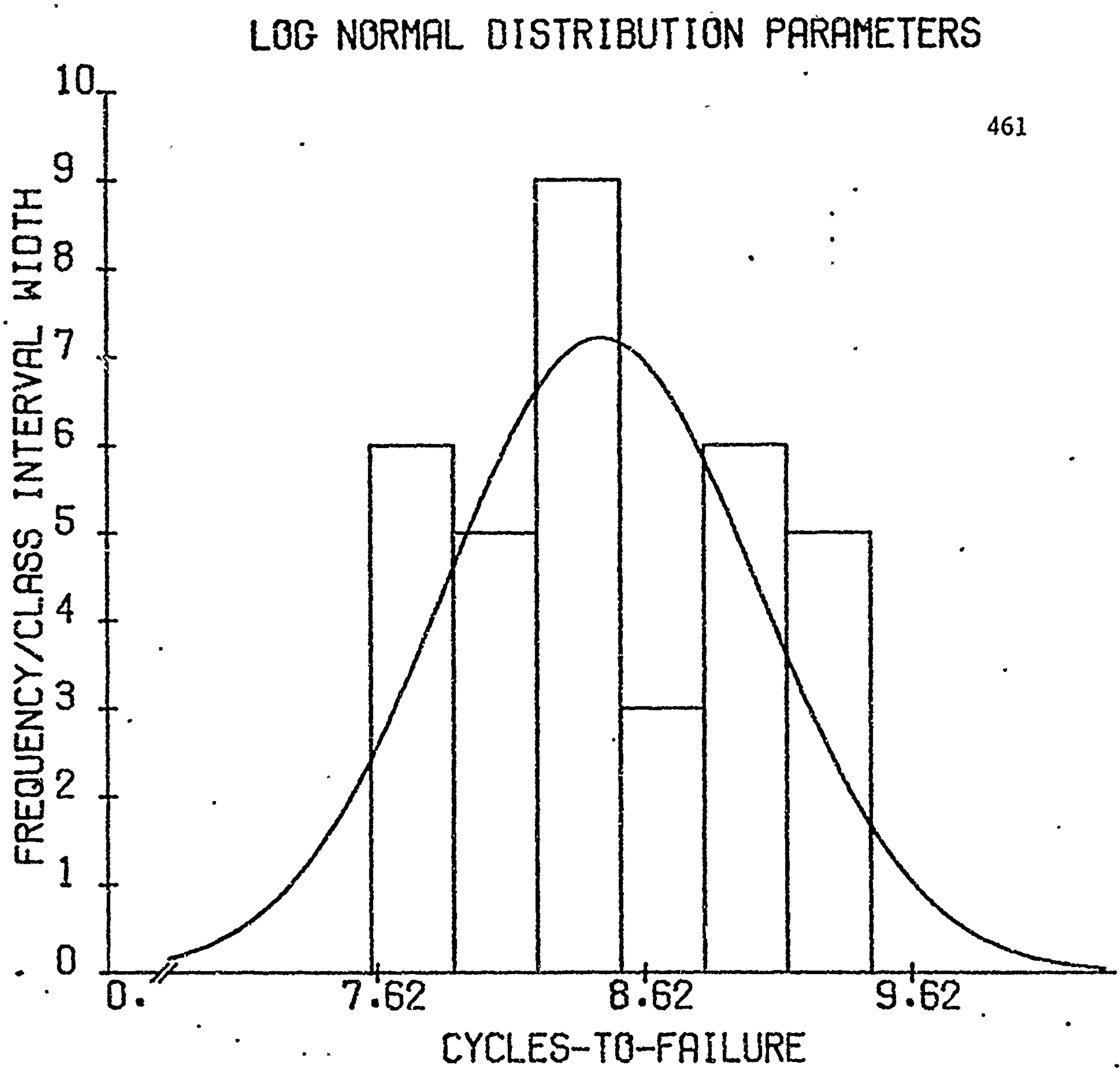
KOLMOGOROV-SMIRNOV TEST: 0.090
CHI-SQUARED TEST: 4.731
WEIBULL SLOPE (BETA): 2.001
MINIMUM LIFE (GAMMA): 9300
SCALE PARAMETER (ETA): 20415

FIG. 9.2-15 CYCLES-TO-FAILURE DISTRIBUTION
SL=80000 PSI
GROUP=94



MEAN VALUE: 5588.2 CYCLES
STANDARD DEVIATION: 3173.0 CYCLES
KOLMOGOROV-SMIRNOV TEST: 0.162
CHI-SQUARED TEST: 1.729
SKEWNESS: 0.696
KURTOSIS: 2.362

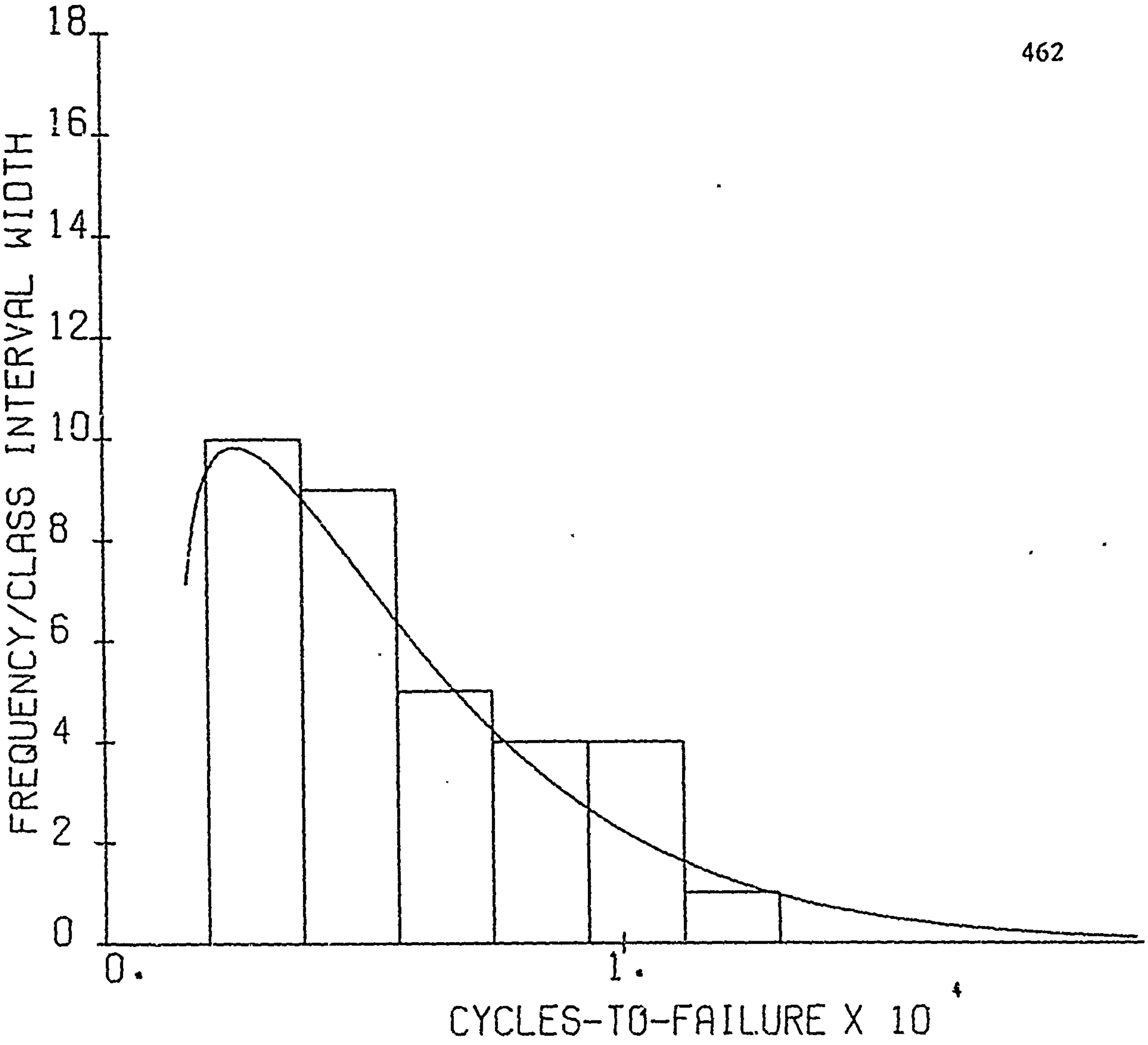
FIG. 9.2-16 CYCLES-TO-FAILURE DIST OF GROUP NO. 95 USING THE WIEDEMANN FATIGUE MACHINE FOR 34 SPECIMENS OF .0937 IN. NOTCH DIAMETER AND .250 IN. NOTCH RADIUS AISI 4130 STEEL ROD. FIXED ALTERNATING STRESS LEVEL OF 95000 PSI.



MEAN VALUE:	8.467	CYCLES
STANDARD DEVIATION:	0.586	CYCLES
KOLMOGOROV-SMIRNOV TEST:	0.108	
CHI-SQUARED TEST:	3.189	
SKEWNESS:	-0.023	
KURTOSIS:	1.859	

FIG. 9.2-17 CYCLES-TO-FAILURE DIST OF GROUP NO. 95 USING THE WIEDEMANN FATIGUE MACHINE FOR 34 SPECIMENS OF .0937 IN. NOTCH DIAMETER AND .250 IN. NOTCH RADIUS AISI 4130 STEEL ROD. FIXED ALTERNATING STRESS LEVEL OF 95000 PSI.

WEIBULL DISTRIBUTION PARAMETERS



KOLMOGOROV-SMIRNOV TEST: 0.085

CHI-SQUARED TEST: 0.751

WEIBULL SLOPE (BETA): 1.203

MINIMUM LIFE (GAMMA): 1500

SCALE PARAMETER (ETA): 4625

FIG. 9.2-18 CYCLES-TO-FAILURE DISTRIBUTION
SL=95000 PSI
GROUP=95

Table 9.2-1 Reduced Data for Group 162, AISI 1038 Steel. Wiedemann Fatigue Machine. See Table 8.2-13.

Staircase method at 3×10^6 cycles

Number of Useful Specimens: 33

Specimen geometry: D = 0.375 in.

d = 0.2700 in.

r = 0.031 in.

Alternating Stress	i	n_i Failures	in_i	$i^2 n_i$
25,000	1	14	14	14
23,000	0	2	0	0
		N = 16	A = 14	B = 14

d = stress increment = 2,000 psi

X_o = lowest stress level = 23,000 psi

$\bar{X}$ = mean (estimate)

$\bar{X} = X_o + d[A/N - 1/2] = 23,000 + 2,000\left[\frac{14}{16} - \frac{1}{2}\right]$

$\bar{X} = 23,750$ psi $\cong 24,000$ psi*

s = standard deviation (estimate)

$s = 1.620\, d[(NB-A^2)/N^2 + 0.029] = 1.620(2,000)\left[\frac{16(14)-14^2}{16^2} + 0.029\right]$

$s = 447$ psi $\cong 400$ psi**

* Rounded off to nearest 1,000 psi

** Rounded off to nearest 100 psi

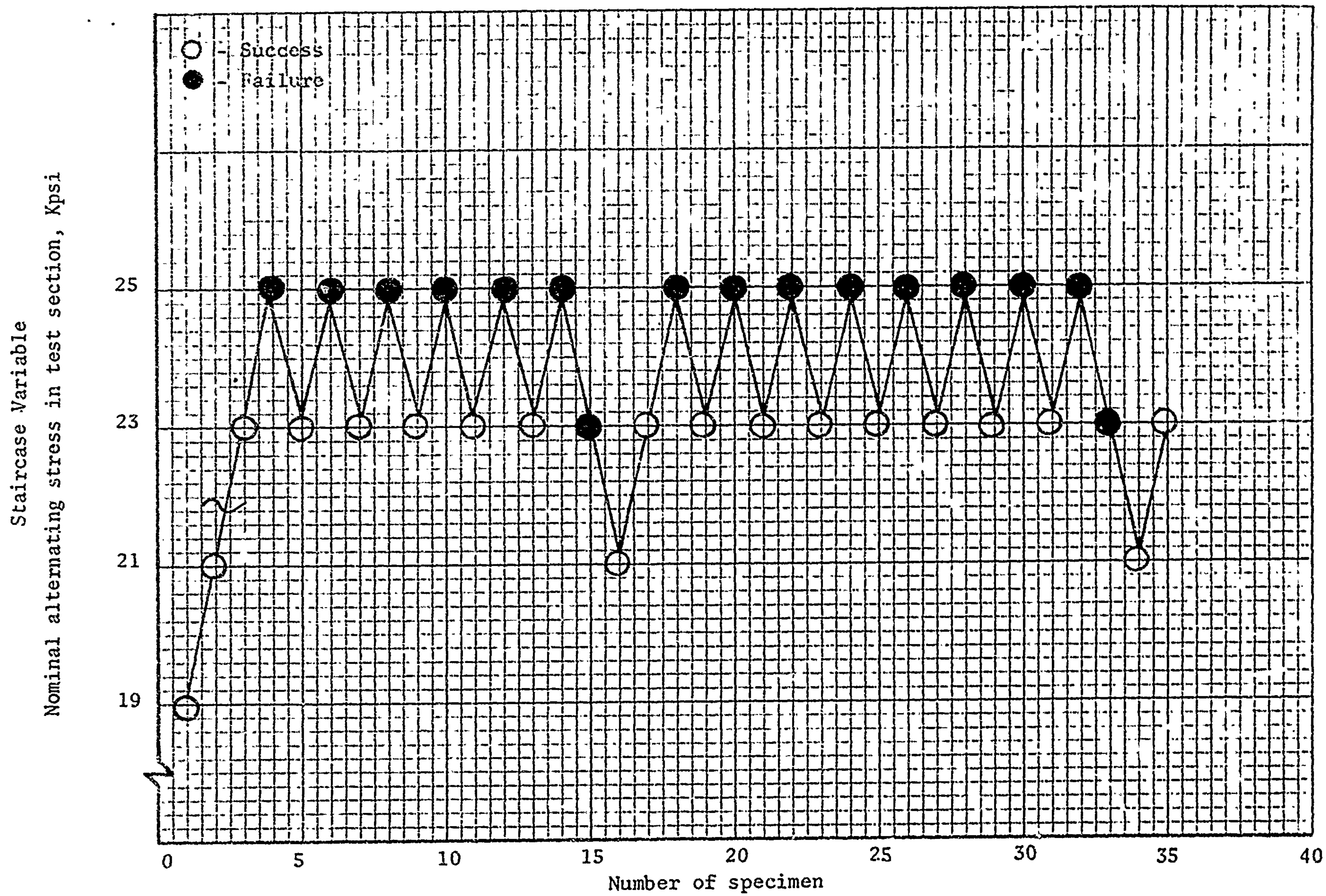


Fig. 9.2-19 Endurance strength data for AISI 1038 steel rod, Group No. 162, groove diameter d= 0.2700 in., groove radius r = 0.31 in. with cut-off at 3 x 10^6 cycles.

Table 9.2-2 Reduced Data for Group 163, AISI 1038 Steel. Wiedemann Fatigue Machine. See Table 8.2-15

Staircase method at 3×10^6 cycles

Number of Useful Specimens: 35

Specimen geometry: D = 0.375 in.
d = 0.2700 in.
r = 0.062 in

Alternating Stress psi	i	n_i Successes	in_i	i^2n_i
27,000	2	9	18	36
25,000	1	5	5	5
23,000	0	3	0	0
		N = 17	A = 23	B = 41

d = stress increment = 2,000 psi

X_o = lowest stress level = 23,000 psi

$\overline{X}$ = mean (estimate)

$$\overline{X} = X_o + d\ A/N + 1/2 = 23{,}000 + 2{,}000\left[\frac{23}{17} + \frac{1}{2}\right]$$

$\overline{X}$ = 26,706 psi

s = standard deviation (estimate)

$$s = 1.620\ d\ (NB-A^2)/N^2 + 0.029 = 1.620(2{,}000)\left[\frac{(17 \times 41 - 23^2)}{17^2} + 0.029\right]$$

s = 1,976 psi

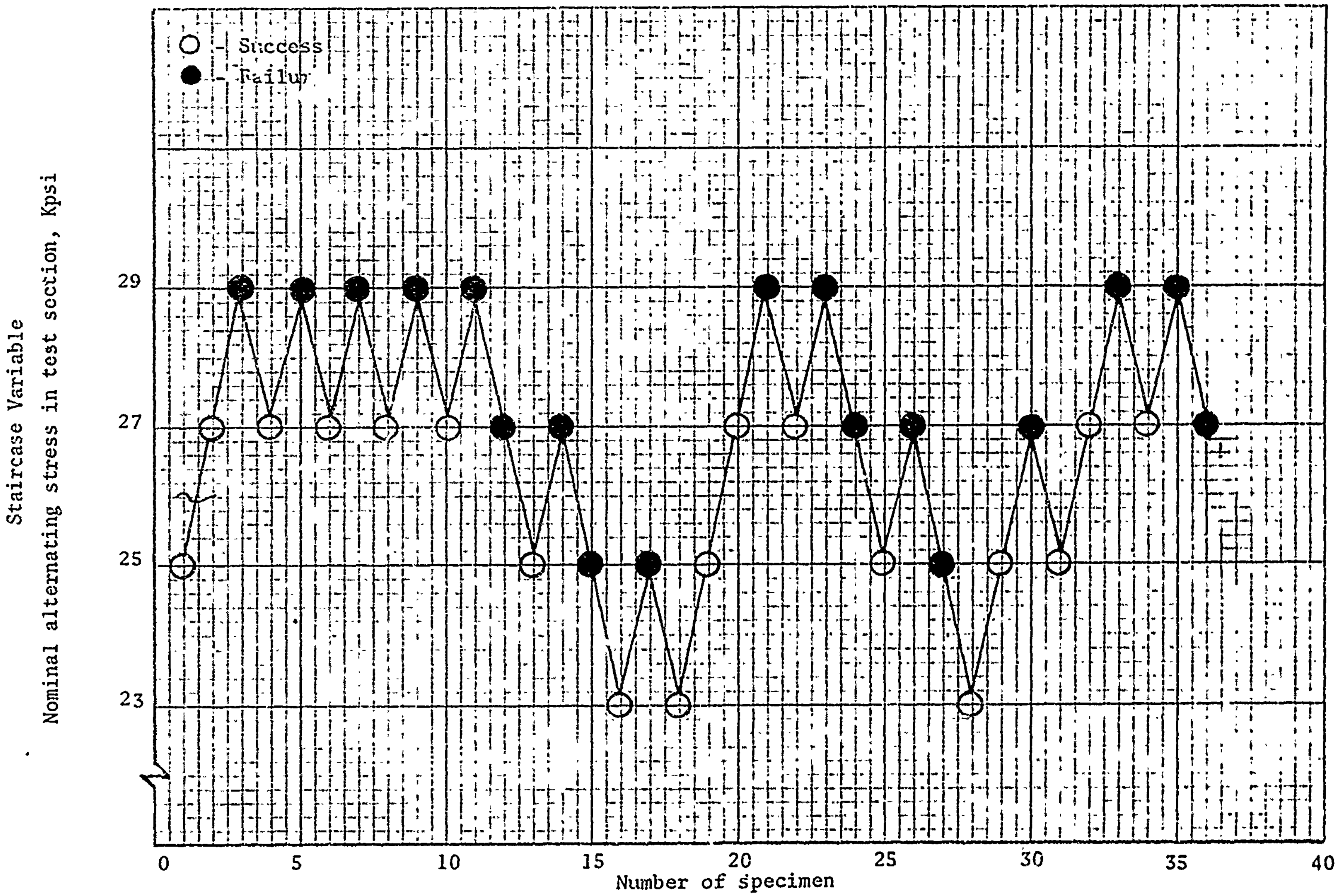


Fig. 9.2-20 Endurance strength data for AISI 1038 steel rod, Group No. 163, groove diameter d = 0.2700 in., groove radius r = 0.062 in. with cut-off at 3 x 10^6 cycles.

Table 9.2-3 Reduced Data for Group 164, AISI 1038 Steel. Wiedemann Fatigue Machine. See Table 8.2-17.

Staircase method at 3×10^6 cycles

Number of Useful Specimens: 37

Specimen geometry: D = 0.375 in.

d = 0.2700 in.

r = 0.125 in.

Alternating Stress	i	n_i Failures	in_i	i^2n_i
34,000	2	2	4	8
32,000	1	9	9	9
30,000	0	7	0	0
		N = 18	A = 13	B = 17

d = stress increment = 2,000 psi

X_o = lowest stress level = 30,000 psi

$\overline{X}$ = mean (estimate)

$\overline{X} = X_o + d[A/N - 1/2] = 30,000 + 2,000 \left[\frac{13}{18} - \frac{1}{2}\right]$

$\overline{X}$ = 30,444 psi ≅ 30,000 psi*

s = standard deviation (estimate)

$s = 1.620\, d[(NB-A^2)/N^2 + 0.029] = 1.620(2,000)\left[\frac{(18 \times 17 - 13^2)}{18^2} + 0.029\right]$

s = 1,464 psi ≅ 1,500 psi**

* Rounded off to nearest 1,000 psi

** Rounded off to nearest 100 psi

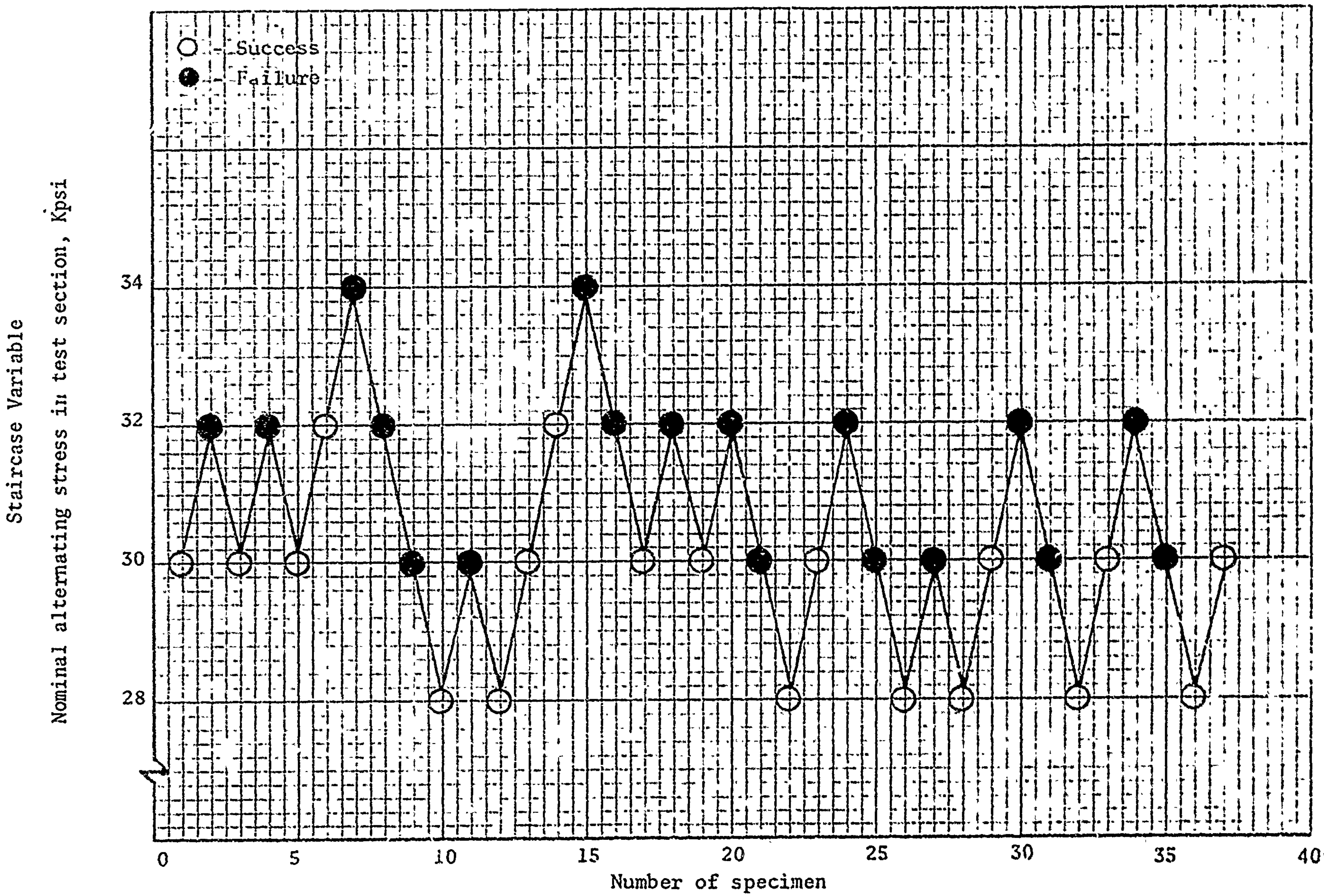


Fig. 9.2-21 Endurance strength data for AISI 1038 steel rod, Group No. 164, groove diameter d = 0.2700 in., groove radius r = 0.125 in. with cut-off at 3 x 10^6 cycles.

Table 9.2-4 Reduced Data for Group 165, AISI 1038 Steel. Wiedemann Fatigue Machine. See Table 8.2-19.

Staircase method at 3×10^6 cycles

Number of Useful Specimens: 35

Specimen geometry: D = 0.375 in.

d = 0.2700 in.

r = 0.250 in.

Alternating Stress	i	n_i successes	in_i	i^2n_i
33,000	2	4	8	16
31,000	1	11	11	11
29,000	0	2	0	0
		N = 17	A = 19	B = 27

d = stress increment = 2,000 psi

X_o = lowest stress level = 29,000 psi

$\overline{X}$ = mean (estimate)

$\overline{X} = X_o + d[A/N + 1/2] = 29,000 + 2,000\left[\frac{19}{17} + \frac{1}{2}\right]$

$\overline{X}$ = 32,240 psi ≅ 32,000 psi*

s = standard deviation (estimate)

$s = 1.620\, d[(NB-A^2)/N^2 + 0.029] = 1.620(2,000)\left[\frac{(17\times27 - 19^2)}{17^2} + 0.029\right]$

s = 1,192 psi ≅ 1,200 psi**

---

* Rounded off to nearest 1,000 psi

** Rounded off to nearest 100 psi

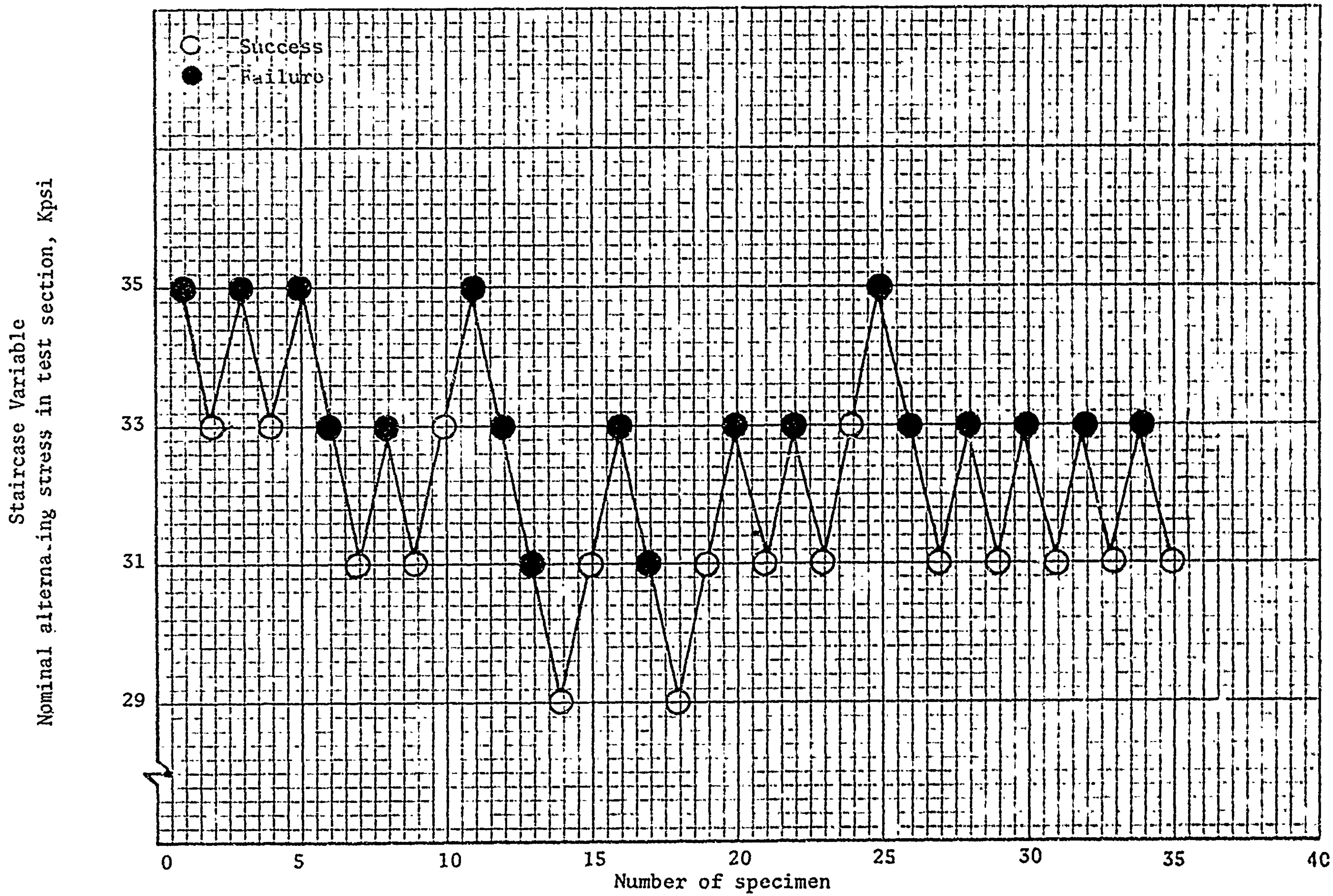


Fig. 9.2-22 Endurance strength data for AISI 1038 steel rod, Group No. 165, groove diameter d = 0.2700 in., groove radius r = 0.250 in., cut-off at 3×10^6 cycles.

Table. 9.2-5 Reduced Data for Group 166, AISI 1038 Steel. Wiedemann Fatigue Machine See Table 8.2-21.

Staircase method at 3×10^6 cycles

Number of Useful Specimens: 35

Specimen geometry: $D = 0.375$ in.
$d = 0.2700$ in.
$r = 1.870$ in.

Alternating Stress psi	i	n_i Successes	in_i	$i^2 n_i$
40,000	3	1	3	9
38,000	2	3	6	12
36,000	1	9	9	9
34,000	0	4	0	0
		N = 17	A = 18	B = 30

d = stress increment = 2,000 psi

X_o = lowest stress level = 34,000 psi

$\overline{X}$ = mean (estimate)

$\overline{X} = X_o + d[A/N + 1/2] = 34,000 + 2,000\left[\frac{18}{17} + \frac{1}{2}\right]$

$\overline{X}$ = 37,118 psi

s = standard deviation (estimate)

$s = 1.620\, d[(NB-A^2)/N^2 + 0.029] = 1.620(2,000)\left[\frac{(17 \times 30 - 18^2)}{17^2} + 0.029\right]$

s = 2,141 psi

* Rounded off to nearest 1,000 psi

** Rounded off to nearest 100 psi

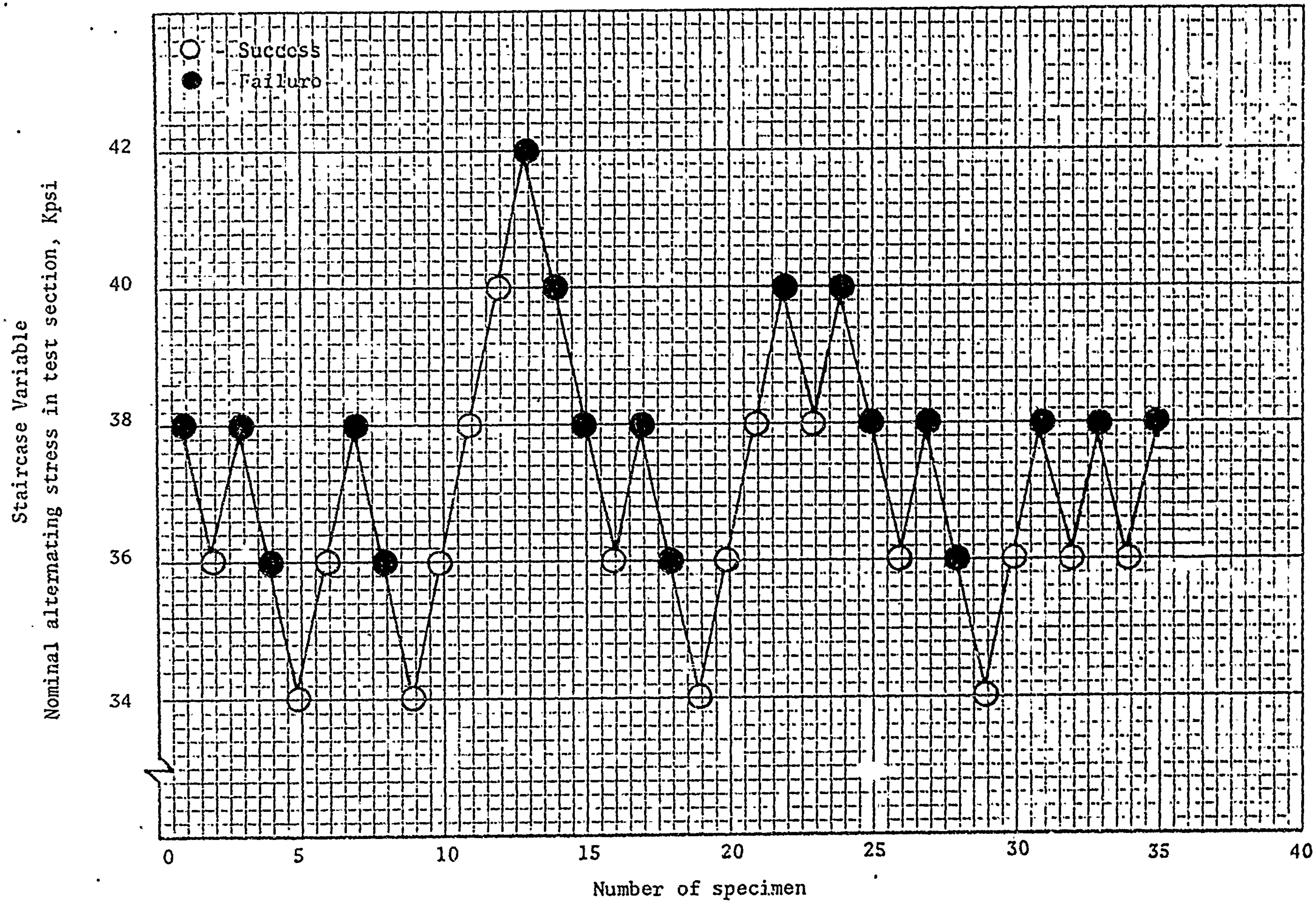


Fig. 9.2-23 Endurance strength data for AISI 1038 steel rod, Group No. 166, groove diameter d = 0.2700 in., groove radius r = 1.87 in. with cut-off at 3 x 10^6 cycles.

9.3 AXIAL FATIGUE MACHINE DATA

Table 9.3-1 Reduced Data for Group 159, AISI 1018 Steel. Axial Fatigue Machine, See Table 8.3-3.

Staircase method at 2×10^6 cycles

Number of Useful Specimens: 35

Specimen geometry: D = 0.375 in.

d = 0.075 in.

r = 2.700 in.

Stress Ratio: r_s = 1.0

Stress Vector psi	i	n_i Failures	in_i	i^2n_i
33,940	3	2	6	18
32,980	2	.7	14	28
32,020	1	6	6	6
31,060	0	1	0	0
		N = 16	A = 26	B = 52

d = stress increment = 960 psi

X_o = lowest stress level = 31,060 psi

$\overline{X}$ = mean (estimate)

$\overline{X} = X_o + d[A/N - 1/2] = 31,060 + 960[\frac{26}{16} - 0.5]$

$\overline{X}$ = 32,140 psi ≅ 32,000 psi*

s = standard deviation (estimate)

$s = 1.620\,d[(NB-A^2)/N^2 + 0.029] = 1.620 \times 960[\frac{832 - 676}{256} + 0.029]$

s = 992.68 psi ≅ 1,000 psi**

* Rounded off to nearest 1,000 psi

** Rounded off to nearest 100 psi

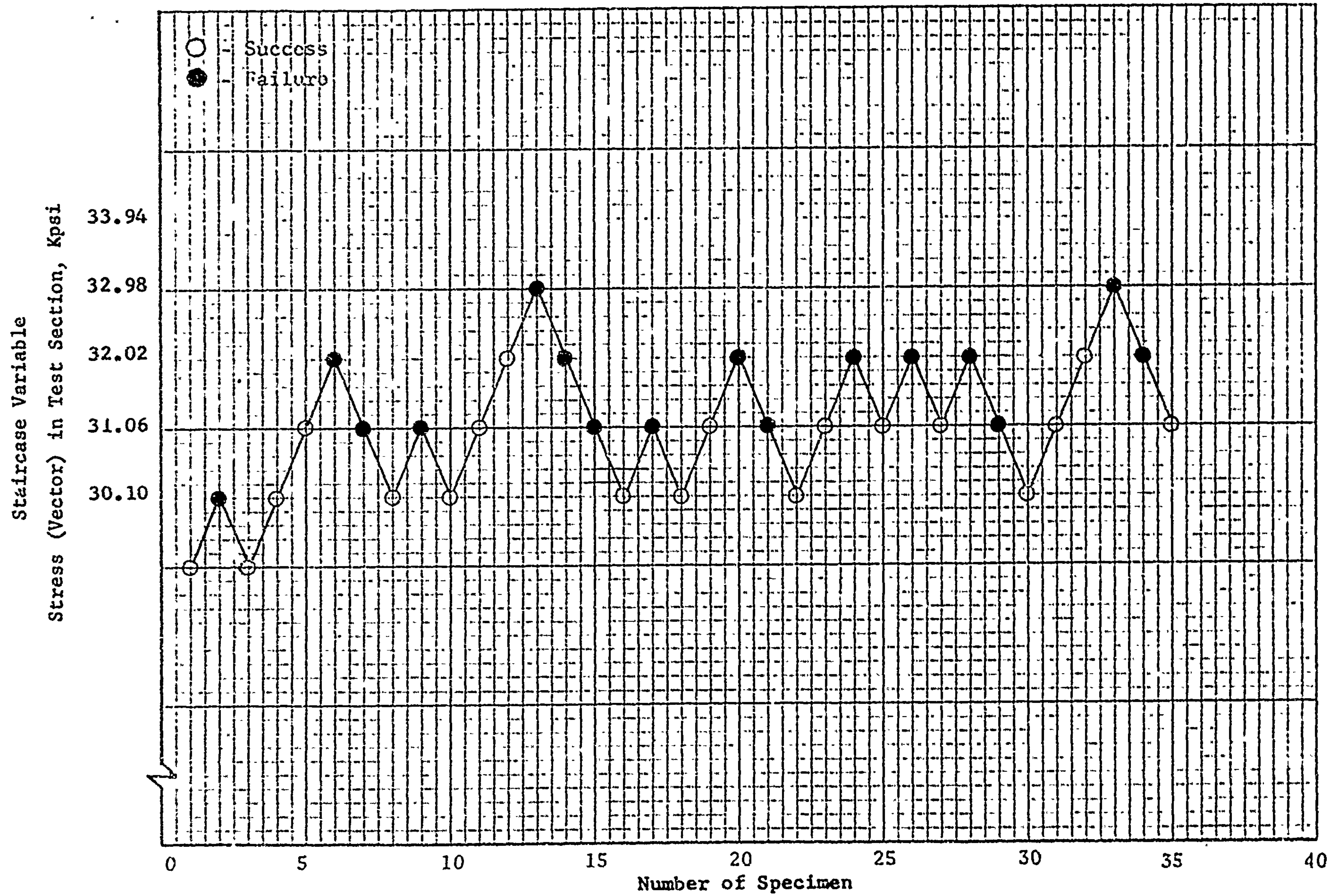


Fig. 9.3-1 Staircase plot of endurance strength data for Group 159, AISI 1018 steel specimens: d = 0.075 inches and grooveradius = 2.70 inches tested at stress ratio r_s = 1.0.

Table 9.3-2 Reduced Data for Group 16Q AISI 1018 Steel. Axial Fatigue Machine, See Table 8.3-4.

Staircase method at 2×10^6 cycles

Number of Useful Specimens: 35

Specimen geometry: D = 0.375 in.

d = 0.075 in.

r = 2.70 in.

Stress Ratio: r_s = 2.0

Stress Vector psi	i	n_i Successes	in_i	i^2n_i
29,100	3	1	3	9
28,100	2	5	10	20
27,100	1	7	7	7
26,100	0	4	0	0
		N = 17	A = 20	B = 36

d = stress increment = 1,000 psi

X_o = lowest stress level = 26,100psi

$\overline{X}$ = mean (estimate)

$\overline{X} = X_o + d[A/N + 1/2] = 26{,}100 + (2{,}000)\ [\frac{20}{17} + \frac{1}{2}]$

$\overline{X}$ = 27,777 psi ≅ 28,000 psi*

s = standard deviation (estimate)

$s = 1.620\,d[(NB-A^2)/N^2 + 0.029] = 1.620\ (1{,}000)[\frac{17 \times 36 - (20)^6}{(17)^2} + 0.029]$

s = 1,235 psi ≅ 1,200 psi**

* Rounded off to nearest 1,000 psi

** Rounded off to nearest 100 psi

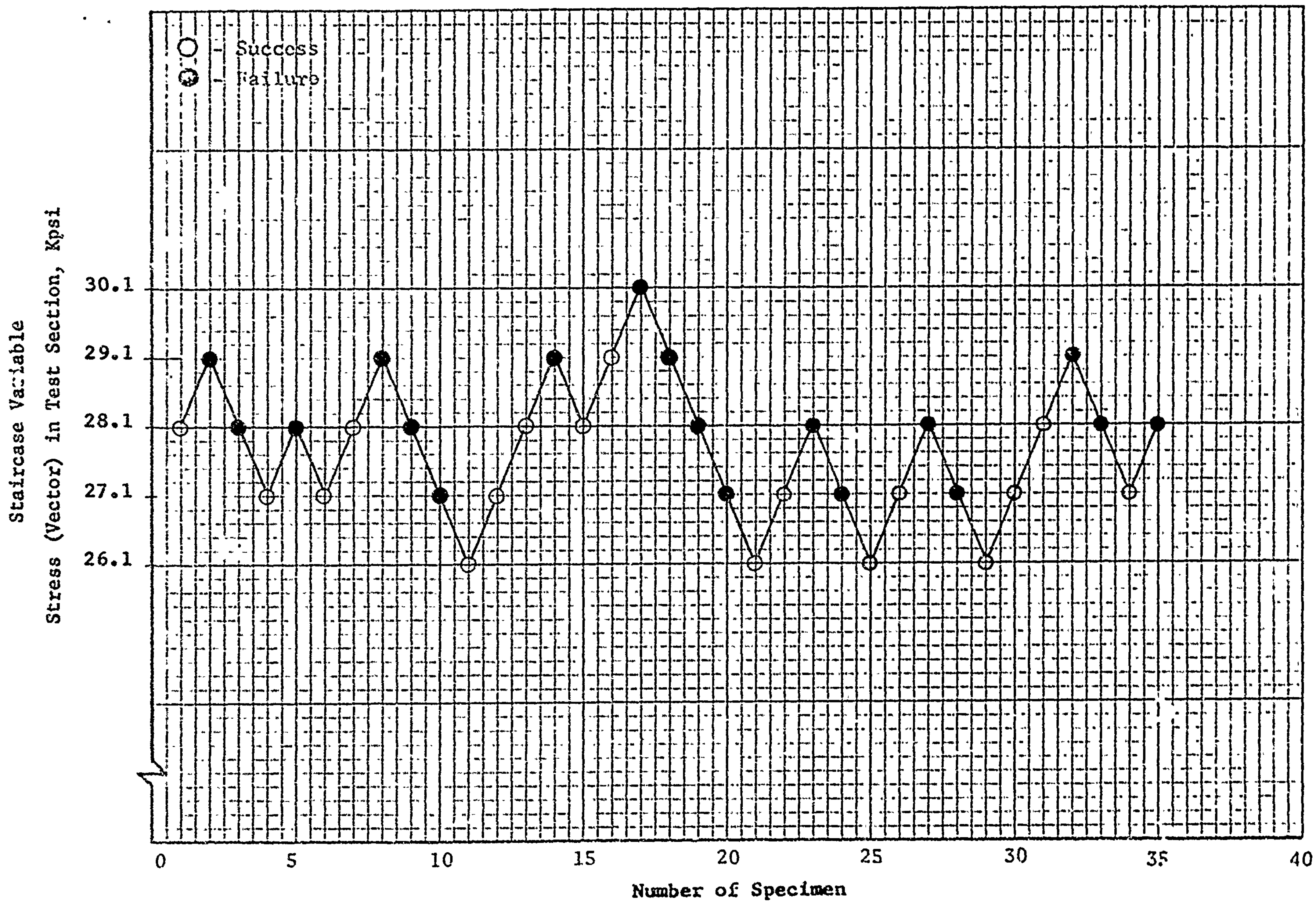


Fig. 9.3-2 Staircase plot of endurance strength data for Group 160, AISI 1018 steel specimens: d = 0.075 inches and grooveradius = 2.70 inches: tested at a stress ratio r_s = 2.0

Table 9.3-3 Reduced Data for Group 161, AISI 1018 Steel. Axial Fatigue Machine, See Table 8.3-5.

Staircase method at 2 x 10^6 cycles

Number of Useful Specimens: 36

Specimen geometry: D = 0.375 in.

d = 0.075 in.

r = 2.700 in.

Stress Ratio: r_s = ∞

Stress Vector psi	i	n_i Failures	in_i	i^2n_i
27,380	2	7	14	28
26,380	1	7	7	7
25,380	0	2	0	0
		N = 16	A = 21	B = 35

d = stress increment = 1,000 psi

X_o = lowest stress level = 25,380 psi

$\overline{X}$ = mean (estimate)

$\overline{X} = X_o + d[A/N - 1/2] = 25,380 + 1,000[\frac{21}{16} - 0.5]$

$\overline{X}$ = 26,192 psi ≅ 26,000 psi*

s = standard deviation (estimate)

$s = 1.620\, d[(NB-A^2)/N^2 + 0.029] = 1.620[\frac{(560 - 441)}{256} + 0.029]$

s = 799.96 psi ≅ 800 psi**

* Rounded off to nearest 1,000 psi

** Rounded off to nearest 100 psi

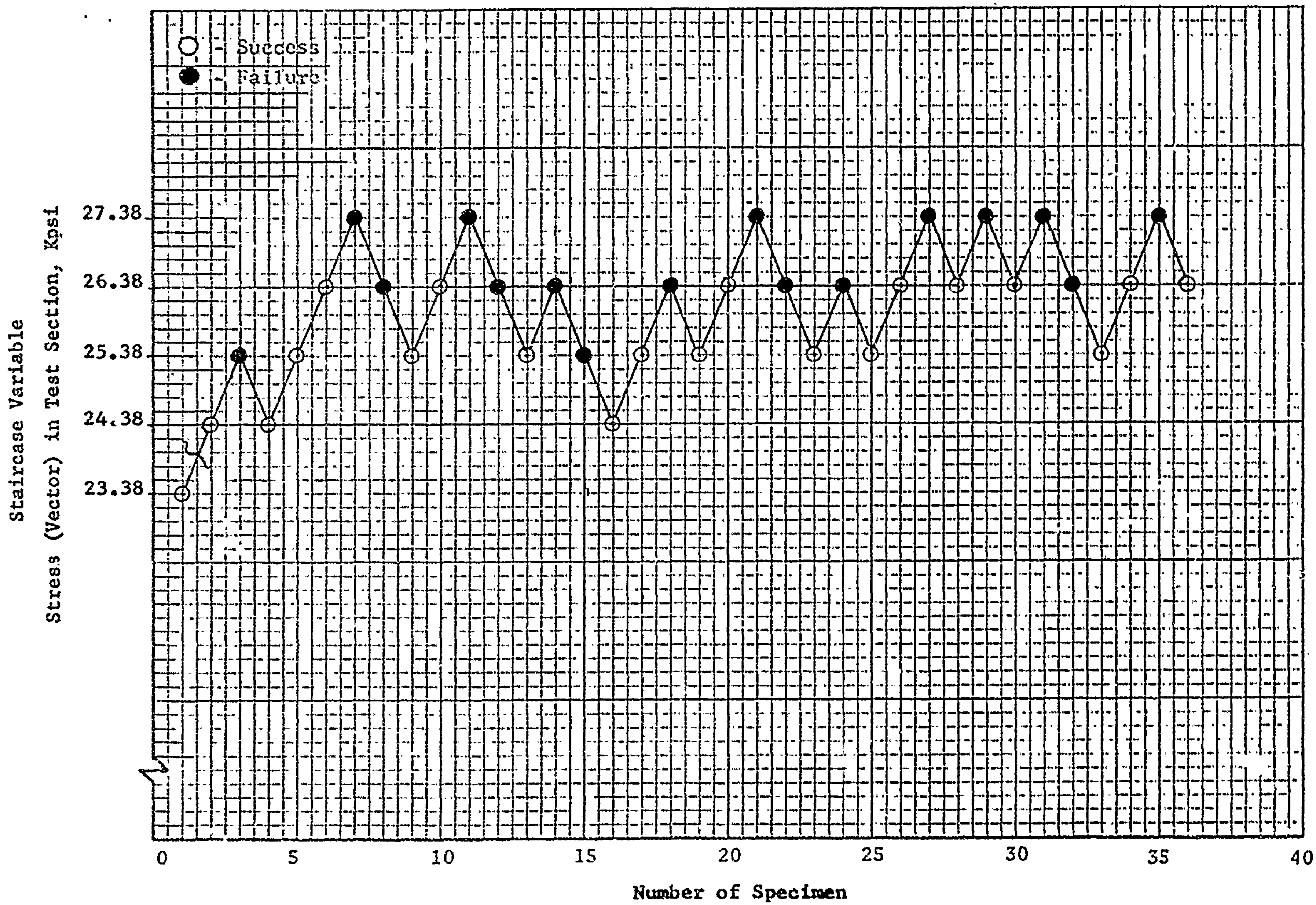


Fig. 9.3-3 Staircase plot of endurance strength data for Group 161, AISI 1018 steel specimens: d = 0.075 inches and groove radius = 2.70 inches; tested at a stress ratio of infinity.

Table 9.3-4 Reduced Data for Group 32, AISI 4130 Steel. Axial Fatigue Machine.

Staircase method at 2×10^6 cycles

Number of Useful Specimens: 27

Specimen geometry: D = 0.3750 in.

d = 0.0651 in.

r = 1.87 in.

Stress Ratio: r_s = 2.0

Stress Vector psi	i	n_i Successes	in_i	i^2n_i
45,665	3	1	3	9
43,650	2	3	6	12
41,635	1	7	7	7
39,620	0	2	0	0
		N = 13	A = 16	B = 28

d = stress increment = 2,015 psi

X_o = lowest stress level = 39,620 psi

$\overline{X}$ = mean (estimate)

$\overline{X} = X_o + d[A/N + 1/2] = 39{,}620 + 2{,}015 \left[\frac{16}{13} + \frac{1}{2}\right]$

$\overline{X}$ = 43,107.5 psi ≅ 43,000 psi*

s = standard deviation (estimate)

$s = 1.620\,d[(NB-A^2)/N^2 + 0.029] = 1.62\ (2{,}015)\left[\frac{13 \times 28 - (16)^2}{(13)^2} + 0.029\right]$

s = 2,180.7 psi ≅ 2,200 psi**

This information supersedes the information reported in Table 4-20, p. 298 of [ ].

* Rounded off to nearest 1,000 psi

** Rounded off to nearest 100 psi

Table 9.3-5 Reduced Data for Group 33, AISI 4130 Steel. Axial Fatigue Machine,

Staircase method at 2 x 10^6 cycles

Number of Useful Specimens: 23

Specimen geometry: D = 0.3750 in.

d = 0.0647 in.

r = 1.87 in.

Stress Ratio: r_s = 1.0

Stress Vector psi	i	n_i Successes	in_i	i^2n_i
53,731	2	4	8	16
51,582	1	2	2	2
49,433	0	4	0	0
		N = 10	A = 10	B = 18

d = stress increment = 2,149 psi

X_o = lowest stress level = 49,433 psi

$\bar{X}$ = mean (estimate)

$\bar{X} = X_o + d[A/N + 1/2] = 49{,}433 + 2{,}149 \left[\frac{10}{10} + \frac{1}{2}\right]$

$\bar{X}$ = 52,656.5 psi ≅ 53,000 psi*

s = standard deviation (estimate)

$s = 1.620\,d[(NB-A^2)/N^2 + 0.029] = 1.62\,(2{,}149)\left[\frac{10 \times 18 - (10)^2}{(10)^2} + 0.029\right]$

s = 2,886.1 psi ≅ 2,900 psi**

This information supersedes the information reported in Table 4-2, p. 299 of [III].

* Rounded off to nearest 1,000 psi

** Rounded off to nearest 100 psi

Table 9.3-6 Reduced Data for Group 34, AISI 4130 Steel. Axial Fatigue Machine,

Staircase method at 2×10^6 cycles

Number of Useful Specimens: 26

Specimen geometry: $D = 0.3750$ in.

$d = 0.0642$ in.

$r = 1.8700$ in.

Stress Ratio: r_s = 0.4

Stress Vector psi	i	n_i Successes	in_i	i^2n_i
74,463	3	1	3	9
72,468	2	3	6	12
70,473	1	5	5	5
68,478	0	3	0	0
		N = 12	A = 14	B = 26

d = stress increment = 1,995 psi

X_o = lowest stress level = 68,478 psi

$\overline{X}$ = mean (estimate)

$\overline{X} = X_o + d[A/N + 1/2] = 68{,}478 + 1{,}995 \left[\frac{14}{12} + \frac{1}{2} \right]$

$\overline{X} = 71{,}803$ psi $\cong$ 72,000 psi*

s = standard deviation (estimate)

$s = 1.620\,d[(NB-A^2)/N^2 + 0.029] = 1.62\,(1{,}995) \left[\frac{12 \times 26 - (14)^2}{(12)^2} + 0.029 \right]$

$s = 2{,}697.2$ psi $\cong$ 2,700 psi**

This information supersedes the information reported in Table 4-22, p. 300 of [III].

* Rounded off to nearest 1,000 psi

** Rounded off to nearest 100 psi

Table 9.3-7 Reduced Data for Group 62***, AISI 4130 Steel Axial Fatigue Machine,

Staircase method at 2×10^6 cycles

Number of Useful Specimens: 21

Specimen geometry: D = 0.373 in.

d = 0.0628 in.

r = 1.87 in.

Stress Ratio: $r_s = 0.1$

Stress Vector psi	i	n_i Failures	in_i	i^2n_i
90,770	1	6	6	6
87,530	0	4	0	0
		N = 10	A = 6	B = 6

d = stress increment = 3,240 psi

X_o = lowest stress level = 87,530 psi

$\bar{X}$ = mean (estimate)

$\bar{X} = X_o + d[A/N - 1/2] = 87{,}530 + 3{,}240 \left[\frac{6}{10} - \frac{1}{2}\right]$

$\bar{X}$ = 87,854 psi ≅ 88,000 psi*

s = standard deviation (estimate)

$s = 1.620d[(NB-A^2)/N^2 + 0.029] = 1.62\ (3{,}240) \left[\frac{10 \times 6 - (6)^2}{(10)^2} + 0.029\right]$

s = 1,411.93 psi ≅ 1,400 psi**

This information supersedes the information reported in Table 15.3.3.1.1, p. 461 of [IV].

* Rounded off to nearest 1,000 psi

** Rounded off to nearest 100 psi

*** Run to check the results of Group 35 reported in Table 4-23, p. 101 of [IV].

Table 9.3-8 Reduced Data for Group 63, AISI 4130 Steel. Axial Fatigue Machine, See Table

Staircase method at 2×10^6 cycles

Number of Useful Specimens: 25

Specimen geometry: $D = 0.375$ in.

$d = 0.047$ in.

$r = 2.70$ in.

Stress Ratio = $r_s = 0.2$

Stress Vector psi	i	n_i Successes	in_i	i^2n_i
81,130	1	6	6	6
78,780	0	6	0	0
		N = 12	A = 6	B = 6

d = stress increment = 2,350 psi

X_o = lowest stress level = 78,780 psi

$\overline{X}$ = mean (estimate)

$\overline{X} = X_o + d[A/N + 1/2] = 78{,}780 + 2{,}350\left[\frac{6}{12} + \frac{1}{2}\right]$

$\overline{X} = 81{,}130$ psi $\cong$ 81,000 psi*

s = standard deviation (estimate)

$s = 1.620\, d[(NB-A^2)/N^2 + 0.029] = 1.620(2{,}350)\left[\frac{12 \times 6 - (6)^2}{(12)^2} + 0.029\right]$

$s = 1062.15$ psi $\cong$ 1,100 psi**

* Rounded off to nearest 1,000 psi

** Rounded off to nearest 100 psi

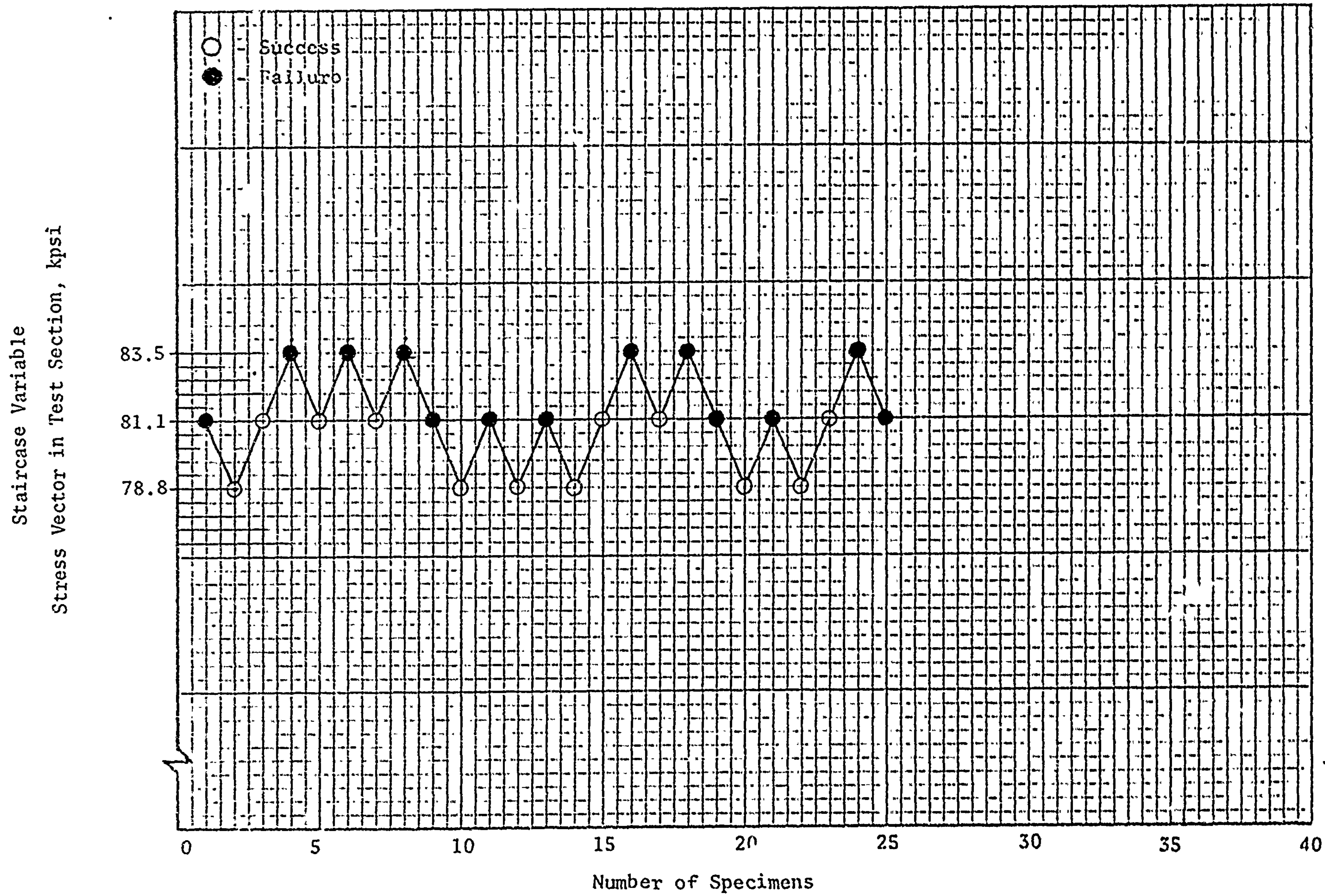


Fig. 9.3-4 Staircase plot of endurance strength data for Group 63, AISI 4130 steel specimens, d = 0.048 in., groove radius = 2.70 in., tested at stress ratio r_s = 0.2.

***

Table 9.3-9 Reduced Data for Group 64, AISI 4130 Steel. Axial Fatigue Machine.

Staircase method at 2×10^6 cycles

Number of Useful Specimens: 23

Specimen geometry: $D = 0.375$ in.

$d = 0.0664$ in.

$r = 1.87$ in.

Stress Ratio: $r_s = \infty$

Stress Vector psi	i	n_i Successes	in_i	i^2n_i
40,310	1	3	3	3
37,431	0	8	0	0
		N = 11	A = 3	B = 3

d = stress increment = 2,879 psi

X_o = lowest stress level = 37,431 psi

$\overline{X}$ = mean (estimate)

$$\overline{X} = X_o + d[A/N + 1/2] = 37,431 + 2,879 \left[\frac{3}{11} + \frac{1}{2}\right]$$

$\overline{X}$ = 39,655 psi ≅ 40,000 psi*

s = standard deviation (estimate)

$$s = 1.620d[(NB-A^2)/N^2 + 0.029] = 1.62\ (2,879)\left[\frac{11 \times 3 - (3)^2}{(11)^2} + 0.029\right]$$

s = 1,060.3 psi ≅ 1,100 psi**

This information supersedes the information reported in Table 15.3.3.1.3, p. 465 of [IV]

* Rounded off to nearest 1,000 psi

** Rounded off to nearest 100 psi

*** Run to check the results of Group 31 reported in Table 4-19, p. 297 of [III]

Table 9.3-10 Reduced Data for Group 111, AISI 1038 Steel. Axial Fatigue Machine.

Staircase method at 2×10^6 cycles

Number of Useful Specimens: 35

Specimen geometry: D = 0.375 in.

d = 0.065 in.

r = 2.70 in.

Stress Ratio: r_s = 0.1

Stress Vector psi	i	n_i Failures	in_i	i^2n_i
59,320	2	6	12	24
57,800	1	6	6	6
56,280	0	5	0	0
		N = 17	A = 18	B = 30

d = stress increment = 1,520 psi

X_o = lowest stress level = 56,280 psi

$\overline{X}$ = mean (estimate)

$$\overline{X} = X_o + d[A/N - 1/2] = 56{,}280 + 1{,}520 \left[\frac{18}{17} - \frac{1}{2}\right]$$

$\overline{X}$ =57,129.4psi ≅ 57,000 psi*

s = standard deviation (estimate)

$$s = 1.620\,d[(NB-A^2)/N^2 + 0.029] = 1.62\ (1{,}520) \left[\frac{17 \times 30 - (18)^2}{(17)^2} + 0.029\right]$$

s = 1,656.2psi ≅ 1,700 psi**

This information supersedes the information reported in Table 15.3.3.2.1, p. 478 of [IV].

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* Rounded off to nearest 1,000 psi

** Rounded off to nearest 100 psi

Table 9.3-11 Reduced Data for Group 112, AISI 1038 Steel. Axial Fatigue Machine.

Staircase method at 2×10^6 cycles

Number of Useful Specimens: 35

Specimen geometry: D = 0.375 in.

d = 0.068 in.

r = 2.70 in.

Stress Ratio: r_s = 0.4

Stress Vector psi	i	n_i Successes	in_i	$i^2 n_i$
50,800	2	5	10	20
48,800	1	10	10	10
46,800	0	2	0	0
		N = 17	A = 20	B = 30

d = stress increment = 2,000 psi

X_o = lowest stress level = 46,800 psi

$\bar{X}$ = mean (estimate)

$\bar{X} = X_o + d[A/N + 1/2] = 46,800 + 2,000 \left[\frac{20}{17} + \frac{1}{2}\right]$

$\bar{X}$ = 50,153 psi ≅ 50,000 psi*

s = standard deviation (estimate)

$s = 1.620\, d[(NB-A^2)/N^2 + 0.029] = 1.62\ (2,000) \left[\frac{17 \times 30 - (20)^2}{(17)^2} + 0.029\right]$

s = 1,327.2 psi ≅ 1,300 psi**

This information supersedes the information reported in Table 15.3.3.2.2, p. 480 of [IV].

* Rounded off to nearest 1,000 psi

** Rounded off to nearest 100 psi

Table 9.3-12 Reduced Data for Group 113, AISI 1038 Steel. Axial Fatigue Machine.

Staircase method at 2×10^6 cycles

Number of Useful Specimens: 35

Specimen geometry: D = 0.375 in.

d = 0.075 in.

r = 2.70 in.

Stress Ratio: r_s = 1.0

Stress Vector psi	i	n_i Successes	in_i	i^2n_i
41,300	4	1	4	16
40,400	3	4	12	36
39,400	2	6	12	24
38,500	1	4	4	4
37,500	0	2	0	0
		N = 17	A = 32	B = 80

d = stress increment = 950 psi

X_o = lowest stress level = 37,500 psi

$\overline{X}$ = mean (estimate)

$\overline{X} = X_o + d[A/N + 1/2] = 37,500 + 950 \left[\frac{32}{17} + \frac{1}{2}\right]$

$\overline{X}$ = 39,763.2 psi ≅ 40,000 psi*

s = standard deviation (estimate)

$s = 1.620\, d[(NB - A^2)/N^2 + 0.029] = 1.62\ (950) \left[\frac{17 \times 80 - (32)^2}{(17)^2} + 0.029\right]$

s = 1,833.9 psi ≅ 1,800 psi**

This information supersedes the information reported in Table 15.3.3.2.3, p. 482 of [IV].

* Rounded off to nearest 1,000 psi

** Rounded off to nearest 100 psi

Table 9.3-13 Reduced Data for Group 114, AISI 1038 Steel. Axial Fatigue Machine.

Staircase method at 2×10^6 cycles

Number of Useful Specimens: 35

Specimen geometry: D = 0.375 in.

d = 0.075 in.

r = 2.70 in.

Stress Ratio: r_s = 2.0

Stress Vector psi	i	n_i Successes	in_i	i^2n_i
34,500	4	1	4	16
33,500	3	6	18	54
32,500	2	3	6	12
31,500	1	5	5	5
30,500	0	2	0	0
		N = 17	A = 33	B = 87

d = stress increment = 1,000 psi

X_o = lowest stress level = 30,500 psi

$\bar{X}$ = mean (estimate)

$\bar{X} = X_o + d[A/N + 1/2] = 30,500 + (1,000)\left[\frac{33}{17} + \frac{1}{2}\right]$

$\bar{X}$ = 32,941 psi ≅ 33,000 psi*

s = standard deviation (estimate)

$s = 1.620\,d[(NB-A^2)/N^2 + 0.029] = 1.62\ (1,000)\left[\frac{17 \times 87 - (33)^2}{(17)^2} + 0.029\right]$

s = 2,233.1 psi ≅ 2,200 psi**

This information supersedes the information reported in Table 15.3.3.2.4, p. 484 of [IV].

* Rounded off to nearest 1,000 psi

** Rounded off to nearest 100 psi

Table 9.3-14 Reduced Data for Group 115, AISI 1038 Steel. Axial Fatigue Machine.

Staircase method at 2×10^6 cycles

Number of Useful Specimens: 35

Specimen geometry: D = 0.375 in.

d = 0.075 in.

r = 2.70 in.

Stress Ratio: $r_s = \infty$

Stress Vector psi	i	n_i Successes	in_i	i^2n_i
31,674	3	5	15	45
30,543	2	6	12	24
29,412	1	5	5	5
28,281	0	1	0	0
		N = 17	A = 32	B = 74

d = stress increment = 1,131 psi

X_o = lowest stress level = 28,281 psi

$\bar{X}$ = mean (estimate)

$$\bar{X} = X_o + d[A/N + 1/2] = 28{,}281 + (1{,}131)\left[\frac{32}{17} + \frac{1}{2}\right]$$

$\bar{X}$ = 30,975.5 psi ≅ 31,000 psi*

s = standard deviation (estimate)

$$s = 1.620\,d[(NB-A^2)/N^2 + 0.029] = 1.62\ (1{,}131)\left[\frac{17 \times 74 - (32)^2}{(17)^2} + 0.029\right]$$

s = 1,536.7 psi ≅ 1,500 psi**

This information supersedes the information reported in Table 15.3.3.2.5, p. 486 of [IV].

* Rounded off to nearest 1,000 psi

** Rounded off to nearest 100 psi